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Report to Congress
Municipal Wastewater Lagoon Study
Volume 2

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The report presents the appendices of the Municipal Lagoon Study. It includes lagoon design, ground water protection; flow rates; sampling; linings; and models.

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APPENDIX 3.1

LAGOON DESIGN AND GROUND-WATER PROTECTION PRACTICES

APPENDIX 3.1

TABLE 3.1-1
WASTEWATER LAGOONS: USES AND SIZING

Lagoon Type	Application	Typical Loading Parameters[a]	Typical Detention Times, Days	Typical Depths[a]	Comments
Facultative	o Raw municipal wastewater o Effluent from primary treatment, trickling filters, aerated ponds, or anaerobic ponds	22-67 kg BOD_5/ha/d	25-180	1.2-2.5 m deep (approximately 4 - 8 ft)[b]	Most commonly used type of lagoon. May be aerobic through entire depth if lightly loaded.
Aerated	o Industrial wastes o Overloaded facultative ponds o Situations where limited land area is available	8-320 kg BOD_5/1000 m^3/d	7-20	2-6 m deep (approximately 6 - 20 ft)[b]	Uses may range from a supplement of photosynthesis to an extended aeration activated sludge process. Requires less land area than facultative lagoons.
Aerobic	o Generally used to treat effluent from other processes. Produces effluent low in soluble BOD_5 and high in algal solids	85-170 kg BOD_5/ha/d	10-40	30-45 cm deep (approximately 1 - 1.5 ft)[b]	Application limited because of effluent quality. Maximizes algae production and (if algae are harvested) nutrient removal. High loadings reduce land requirements.
Anaerobic	o Industrial wastes	160-800 kg BOD_5/1000 m^3/d	20-50	2.5-5 m deep (approximately 8 - 16 ft)[b]	Odor production usually a problem. Subsequent treatment normally required.

Source: Reference 1

[a] Metric Units: kg = kilogram; ha = hectare; d = day; m = meter; m^3 = cubic meter; cm = centimeter

[b] English units: ft = feet

APPENDIX 3.1

TABLE 3.1-2

STATE REQUIREMENTS FOR GROUND-WATER PROTECTION AT MUNICIPAL WASTEWATER LAGOONS

State	Lining Requirements	Seepage or Permeability Limitations	Monitoring Requirements and Remarks
Alabama	Liners required. Lagoon impoundment guidelines state that earthen materials used as liners must be at least 2 feet thick.	Permeability of earthen materials = 1×10^{-7} cm/sec. Permeability of synthetic materials = 1×10^{-12} cm/sec.	Monitoring wells required. Monitoring can be required if geological evaluation by the State shows that there is potential for contamination of drinking wells.
Alaska	No specific lining requirements.	No specific allowable seepage rate or permeability. Decided on case-by-case basis.	Monitoring wells not required. Sites evaluated on a case-by-case basis.
Arkansas	No specific lining requirements.	Ten-State Standards (Recommended Standards for Sewage Works by Committee of Great Lakes-Upper Mississippi River Board of State Sanitary Engineers, 1978) are followed. Standards call for percolation rate of 500 gallons/acre/day or less.	Monitoring wells not required.
Arizona	No specific lining requirements.	No specific allowable seepage rate or permeability.	Monitoring wells required on a case-by-case basis. Lagoon requirements depend on location, depth to ground water, distance from water supply wells, and any unusual conditions.
California	Need for liners evaluated on a case-by-case basis. Depth to ground water is an important consideration.	No specific allowable seepage rate or permeability. Decided on a case-by-case basis.	Monitoring wells required on a case-by-case basis.
Colorado	Lining required. No restrictions on type of liner.	Design criteria call for a maximum allowable seepage rate of 1/32 in/day.	Monitoring wells are not required.
Connecticut	No specific lining requirements.	No specific allowable seepage rate or permeability. Decided on a case-by-case basis.	Need for monitoring wells evaluated on a case-by-case basis. No treatment lagoons in the State. (There are septage lagoons in the State.)
Delaware	Lining generally required. Some older facilities may not be lined.	Ten-State Standards followed (maximum percolation rate of 500 gallons/acre/day).	Monitoring wells not required unless lagoon is unlined.
Florida	No specific lining requirements.	No specific allowable seepage rate or permeability.	Lagoons may not be used for primary treatment, but they may be used for secondary treatment. Three monitoring wells required for unlined lagoons (1 upgradient and 2 downgradient).

APPENDIX 3.1

TABLE 3.1-2, Continued

STATE REQUIREMENTS FOR GROUND-WATER
PROTECTION AT MUNICIPAL WASTEWATER LAGOONS

State	Lining Requirements	Seepage or Permeability Limitations	Monitoring Requirements and Remarks
Georgia	No specific lining requirements.	Maximum allowable seepage rate of 1/8 in/day.	Monitoring wells not required. Guidelines for lagoon construction are being developed; the requirement of monitoring wells is being considered.
Hawaii	No specific lining requirements.	No specific allowable seepage rate or permeability.	Monitoring wells not required. Lagoon requirements handled on a case-by-case basis. (Hawaii has only 1 or 2 municipal wastewater treatment lagoons.)
Idaho	No specific lining requirements; however, very few lagoons in the State do not have liners.	Maximum allowable seepage rate is 1/4 in/day, less in some cases as determined by case-by-case review. Higher allowable seepage rate if not primary treatment lagoon.	Monitoring wells not required. Idaho follows Ten-State Standards.
Illinois	No specific lining requirements.	No specific allowable seepage rate or permeability.	Monitoring wells not required. Illinois has many areas with dense, compacted soils. Lagoon requirements handled on a case-by-case basis.
Indiana	Lining required to meet seepage limitations. Liners can be constructed of clay, bentonite or synthetic materials.	Maximum allowable permeability of 1×10^{-7} cm/sec.	Monitoring wells not required. Indiana follows Ten-State Standards.
Iowa	No specific lining requirements.	Design standards for new construction require that seepage be less than 1/16 in/day with lagoon filled to 6 feet (adopted 1979).	Monitoring wells not required. Some older lagoons do not meet 1/16 in/day seepage rate.
Kansas	No specific lining requirements.	Maximum allowable seepage rate of 1/4 in/day.	Monitoring wells required on a case-by-case basis.
Kentucky	No specific lining requirements.	No specified allowable seepage rate or permeability. Kentucky follows Ten-State Standards percolation rate of 500 gallons/acre/day or less.	Monitoring wells not required. Not many lagoons in state; last one approved was 6 or 7 years ago. Ground-water Section of Department of Environmental Protection formed within past 6 months.
Louisiana	No specific lining requirements.	No specific allowable seepage rate or permeability.	No monitoring wells required unless lagoon receives industrial waste. Each lagoon proposal reviewed on its individual merits.

APPENDIX 3.1

TABLE 3.1-2, Continued

STATE REQUIREMENTS FOR GROUND-WATER
PROTECTION AT MUNICIPAL WASTEWATER LAGOONS

State	Lining Requirements	Seepage or Permeability Limitations	Monitoring Requirements and Remarks
Maine	No specific lining requirements.	500 gallon/acre/day percolation rate used as guideline.	Monitoring wells required on a case-by-case basis.
Maryland	Lining required to meet permeability limitations.	Maximum permeability of 1×10^{-8} cm/sec.	Monitoring wells not required.
Massa-chusetts	No specific regulations or guidelines for liners. Most lagoons in the State are lined with either natural or synthetic materials.	No specific allowable seepage rate or permeability.	Monitoring wells not required. Lagoon designs approved on a case-by-case basis.
Michigan	Liners required to meet seepage limitations.	Maximum allowable seepage rate is 1/8 in/day.	Need for monitoring wells evaluated on a site-by-site basis.
Minnesota	Linings required. Two 6-inch lifts of compacted clay is an acceptable lining for most sites.	Maximum percolation rate of 500 gallons/acre/day (equivalent to a seepage of 1/64 in/day). Prior to July 1977, maximum percolation rate was 3,500 gallons/acre/day via compaction of clay materials.	Monitoring not normally required.
Mississippi	No specific lining requirements. Lining requirements determined on a case-by-case basis.	Ten-State Standards followed (maximum allowable percolation rate of 500 gallons/acre/day).	Monitoring wells not required. Municipalities are not required to prove that they are within the limits of the Ten-State Standards. Groundwater Quality Branch recently developed by Mississippi Bureau of Pollution Control.
Missouri	Lagoons must be lined or sealed to meet maximum percolation rates.	Lagoons which have flows of less than 22,500 gallons/day may have a maximum percolation rate of 0.25 in/day. Lagoons which have flows greater than 22,500 gallons/day may have a maximum percolation rate of 1/16 in/day.	Monitoring wells not normally required. Missouri could require wells if lagoon is located in an area with a severe potential to contaminate ground water (as determined geological study).
Montana	Lining required to meet allowable seepage rate.	Ten-State Standards followed (maximum percolation rate of 500 gallons/acre/day). Seepage of up to 6 in/year allowed for primary cells; 15 in/year for secondary cells.	Monitoring wells not required.
Nebraska	No specific lining requirements.	Guideline for allowable seepage is 1/8 in/day for design and 1/4 in/day in use.	Monitoring wells not generally required.

APPENDIX 3.1

TABLE 3.1-2, Continued

STATE REQUIREMENTS FOR GROUND-WATER PROTECTION AT MUNICIPAL WASTEWATER LAGOONS

State	Lining Requirements	Seepage or Permeability Limitations	Monitoring Requirements and Remarks
Nevada	No specific lining requirements. Generally primary cells are required to be lined.	No specific allowable seepage rate or permeability. Decided on a case-by-case basis.	Monitoring wells may be required by permit. Nevada has no written regulations. All lagoons must receive a ground-water discharge permit.
New Hampshire	Liners required. Most liners currently in use are synthetic.	Maximum allowable percolation rate is 500 gallons/acre/day.	New lagoons must be monitored. No existing lagoons in the State are being monitored. Several systems under construction will require monitoring wells.
New Jersey	Liners required. All types of lining materials are acceptable.	Permeability of 1×10^{-7} cm/sec for the material being contained.	Three monitoring wells are required for all surface impoundments (including lagoons). Monitoring plan is site-specific and must be approved by the New Jersey Department of Environmental Protection.
New Mexico	No specific lining requirements. Lining requirements determined on a case-by-case basis.	Site-specific. Must demonstrate that ground water will not be contaminated.	Monitoring wells not required. In some areas of the State the ground-water table is 800 feet below the lagoon bottom (no lining would be required by the state).
New York	No specific lining requirements.	Ten-State Standards are followed (maximum percolation rate of 500 gallons/acre/day).	Monitoring wells not required.
North Carolina	Case-by-case review. Water Quality Branch, which issues permits, almost always recommends liners.	On-site soils allowed as liners if 1 foot of the compacted soil has a permeability of 1×10^{-6} cm/sec.	Monitoring wells may be required for new lagoons on a case-by-case basis. Existing lagoons may be required to install monitoring wells upon permit reissue.
North Dakota	Lining required. Clay liners are usually used.	Guidelines require allowable seepage rate of 1/16 in/day for design and 1/8 in/day in use. A percolation test is required.	Monitoring wells are not usually required. More stringent requirements could be imposed if impact of ground-water contamination is serious. Land damage to crops from horizontal seepage is occasionally a problem.
Ohio	No specific lining requirements. Lining is often required as part of a case-by-case review.	Ten-State Standards are followed (maximum percolation rate of 500 gallons/acre/day).	Monitoring wells not required.
Oklahoma	Lining required. Acceptable liners include a 12-inch layer of clay, a 4-inch layer of bentonite, or a vinyl liner.	Permeability shall not exceed 1×10^{-7} cm/sec.	Monitoring wells not normally required.

APPENDIX 3.1

TABLE 3.1-2, Continued

STATE REQUIREMENTS FOR GROUND-WATER
PROTECTION AT MUNICIPAL WASTEWATER LAGOONS

State	Lining Requirements	Seepage or Permeability Limitations	Monitoring Requirements and Remarks
Oregon	Liners required to meet seepage rates. Most liners in the State are bentonite; there are a few synthetic liners in use.	Maximum allowable seepage rate is 1/4 in/day.	Monitoring wells not required.
Pennsylvania	Lagoons must be lined or sealed to meet permeability requirements. Synthetic liners shall have a minimum thickness of .030 inches (30 mils).	Permeability may not exceed 1×10^{-7} cm/sec.	One groundwater observation point required - may be new or existing wells, springs, well points or lysimeters, or rocklined test pits or trenches. Underdrains or use of leak detection techniques are alternatives to monitoring.
Rhode Island	Not applicable.	Not applicable.	Construction of wastewater treatment lagoons not approved or allowed. No municipal wastewater treatment lagoons in the State.
South Carolina	All new lagoons must be lined. Areas which are classified as critical must have synthetic liners; non-critical areas may have bentonite liners.	Ten-State Standards followed (maximum percolation rate of 500 gallons/acre/day).	Three monitoring wells sometimes required for older lagoon systems.
South Dakota	Liners required.	Maximum allowable seepage rate is 1/16 in/day (may be 1/8 in/day on secondary lagoons).	Monitoring wells not required.
Tennessee	No specific lining requirements.	No specific allowable seepage rate or permeability.	Monitoring wells not required. Most lagoons are in the western part of the State, where the ground-water table is often 100 feet from the lagoon bottom.
Texas	No specific lining requirements. Lining required on a case-by-case basis. Synthetic liners must be at 20 mils thick.	Soil parameters for in-situ or placed and compacted clay - more than 30 percent must pass No. 200 sieve, liquid limit must be greater than 30 percent, plasticity index must exceed 15, and the minimum thickness is 2 feet.	Monitoring wells not required.
Utah	Lining required. If no natural materials nearby, synthetic liners may be used.	Maximum allowable seepage rates: for design, 1/8 in/day; in use, 1/4 in/day.	Monitoring wells have not been required in the past. State is developing standards for monitoring of lagoons in areas where ground-water is used as drinking water.
Vermont	Lining required. In most cases synthetic; if conditions are good, clay or bentonite may be used.	No specific allowable seepage rate or permeability. Determined on a case-by-case basis.	Monitoring wells not required.

APPENDIX 3.1

TABLE 3.1-2, Continued

STATE REQUIREMENTS FOR GROUND-WATER PROTECTION AT MUNICIPAL WASTEWATER LAGOONS

State	Lining Requirements	Seepage or Permeability Limitations	Monitoring Requirements and Remarks
Virginia	Lining required to meet permeability requirements. Liner thickness shall be no less than .020 inches (20 mils) for synthetic liners.	Permeability shall not exceed 1 x 10^{-6} cm/sec.	Monitoring wells required on a case-by-case basis.
Washington	Liners may be required to meet seepage rates.	Maximum allowable seepage rate is 1/4 in/day; designed for no leakage.	Monitoring wells required for unlined lagoons and lined lagoons where aquifer of special importance exists.
West Virginia	Liners required in some cases (determined on a case-by-case basis).	No specific allowable seepage rate or permeability.	Monitoring wells not required.
Wisconsin	Lining required to meet allowable seepage rates. Synthetic liners must be at least 30 mils thick.	Maximum percolation rate of 1,000 gallons/acre/day. The permeability of soil or bentonite liners shall not exceed 1 x 10^{-7} cm/sec.	Monitoring wells not required.
Wyoming	Lining required on a case-by-case basis. Minimum thickness of synthetic liner is 30 mils.	Maximum allowable seepage rate is 1/8 in/day.	Monitoring wells sometimes required on a case-by-case basis.

Data collected in mid-1985.

APPENDIX 3.1

TABLE 3.1-3

SEEPAGE RATES FOR VARIOUS LINER MATERIALS[a]

Material	Thickness (inches)	Minimum Expected Seepage Rate Assuming a 20-foot Water Column after 1 Year of Service (inches/day)
Open sand and gravel	-	96
Loose earth	-	48
Loose earth plus chemical treatment*	-	12
Loose earth plus bentonite*	-	10
Earth in cut	-	12
Soil cement (continuously wetted)	4	4
Gunite	1.5	3
Asphalt concrete	4	1.5
Unreinforced concrete	4	1.5
Compacted earth	36	0.3
Exposed prefabricated asphalt panels	0.5	0.03
Exposed synthetic membranes	0.045	0.001

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[a] The data are based on actual installation experience. The chemical and bentonite treatments "(*)" depend on pretreatment seepage rates. (Values are assumed for loose, uncompacted earth.)

Source: Reference 2.

APPENDIX 3.1

TABLE 3.1-4

SUMMARY OF STATE GROUND-WATER MONITORING REQUIREMENTS FOR MUNICIPAL WASTEWATER LAGOONS

	Minimum Number of Wells		Sampling Frequency (times per year)		
State	Upgradient	Downgradient	First Year	Thereafter	Monitoring Parameters
Arizona	-[a]	-[a]	-[a]	-[a]	-[a]
California	1	1	2-4	2-4	NO_3-N, total N, Cl, TDS, Na
Connecticut	1	2	4-12	4-12	NO_3-N, NH_3-N, TKN, Cl, Total P, fecal coliform
Florida	1	1	4	4	Drinking water standards, toxics, others
Kansas	1	-[a]	2-4	2-4	NO_3-N, NH_3-N, Total P or PO_4, SO_4
Maine	1	3	-[b]	-[b]	pH, BOD, SS, NO_3-N, NH_3-N, TKN
Michigan	-[a]	-[a]	-[a]	-[a]	-[a]
Minnesota	-[a]	-[a]	-[a]	-[a]	NO_3-N, NH_3-N, TKN, Cl, EC, pH
Nevada	-[a]	-[a]	-[a]	-[a]	-[a]
New Hampshire	-[a]	-[a]	-[a]	-[a]	NO_3-N, pH, Total P, BOD or COD, metals, EC
New Jersey	1	2	4	4	NH_3-N, NO_3-N, TKN, pH, TDS
New Mexico	-[a]	-[a]	3	3	Total N, NO_3-N, Cl, TDS, fecal coliform
North Carolina	1	1	3	3	NO_3-N, NH_3-N, TDS, Cl, Total coliforms, pH, EC, water level

APPENDIX 3.1

TABLE 3.1-4, Continued

SUMMARY OF STATE GROUND-WATER MONITORING REQUIREMENTS FOR LAGOONS

	Minimum Number of Wells		Sampling Frequency (times per year)		
State	Upgradient	Downgradient	First Year	Thereafter	Monitoring Parameters
Pennsylvania	-[a]	1	-[a]	-[a]	-[a]
South Carolina	1	2	4	2	NO_3-N, NH_3-N, Total P, pH, Cl, Na, TDS, TOC, fecal coliform, alkalinity
Virginia	1	2	12	-[c]	NO_3-N, Cl, TOC, pH, Total P, hardness, alkalinity, EC, total coliform, others on a case-by-case basis
Washington	1	1	-[b]	-[b]	NO_3-N, total coliform
Wyoming	1	2	1	1	NH_3-N, NO_3-N, pH, Cl, TDS, boron, selenium

[a] Site-specific.
[b] Depends on flow rate.
[c] Data not available.

Source: Reference 3.

APPENDIX 3.2

LAGOON INVENTORY DATA

DESIGN AND FLOW CHARACTERISTICS OF MUNICIPAL WASTE-WATER LAGOONS IN THE UNITED STATES

USEPA	DESIGN FLOW < 0.1 MGD				DESIGN FLOW 0.1 - 0.49 MGD				DESIGN FLOW 0.5 - 1.0 MGD				DESIGN FLOW > 1.0 MGD			
REGION/STATE	# OF	FLOW,MGD			# OF	FLOW,MGD			# OF	FLOW,MGD			# OF	FLOW,MGD		
	FAC	DOMES	INDUS	TOTAL	FAC	DOMES	INDUS	TOTAL	FAC	DOMES	INDUS	TOTAL	FAC	DOMES	INDUS	TOTAL
CONNECTICUT	0	0.00	0.00	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0.00
CONNECTICUT	1	0.06	0.02	0.09	0	0.00	0.00	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0.00
MAINE	1	0.09	0.00	0.09	2	0.35	0.00	0.35	1	0.74	0.00	0.74	6	7.56	6.35	13.92
MASSACHUSETTS	2	0.04	0.07	0.12	0	0.00	0.00	0.00	1	0.49	0.00	0.49	0	0.00	0.00	0.00
NEW HAMPSHIRE	5	0.22	0.00	0.22	14	3.39	0.17	3.57	4	1.42	1.37	2.80	3	1.94	3.27	5.22
VERMONT	8	0.47	0.01	0.49	9	2.05	0.05	2.11	4	2.31	0.19	2.51	0	0.00	0.00	0.00
REGION 1	17	0.00	0.12	1.05	25	292.85	0.23	6.03	10	0.00	0.00	823.67	9	9.76	0.00	19.14
NEW JERSEY	0	0.00	0.00	0.00	1	0.19	0.00	0.19	0	0.00	0.00	0.00	0	0.00	0.00	0.00
NEW YORK	3	0.15	0.00	0.15	5	1.13	0.33	1.47	2	0.89	0.09	0.99	2	2.57	0.00	2.57
REGION 2	3	0.15	0.00	0.15	6	1.33	0.33	1.67	2	0.89	0.09	0.99	2	2.57	0.00	2.57
DELAWARE	0	0.00	0.00	0.00	0	0.00	0.00	0.00	3	1.25	0.70	1.95	0	0.00	0.00	0.00
MARYLAND	12	0.59	0.00	0.59	14	3.12	0.15	3.28	2	1.57	0.00	1.57	2	2.33	0.39	2.73
PENNSYLVANIA	11	1.39	0.00	1.39	5	0.87	0.00	0.87	0	0.00	0.00	0.00	0	0.00	0.00	0.00
VIRGINIA	21	0.98	0.00	0.98	20	4.48	0.00	4.48	1	0.75	0.00	0.75	0	0.00	0.00	0.00
WEST VIRGINIA	8	0.52	0.00	0.52	11	2.63	0.17	2.81	4	2.31	0.00	2.31	1	0.99	0.09	1.09
REGION 3	52	3.50	0.00	3.50	50	11.12	0.33	11.46	10	5.90	0.70	6.61	3	3.33	0.49	3.83
ALABAMA	7	0.42	0.00	0.42	44	10.41	0.25	10.67	14	8.55	0.13	8.69	1	1.49	0.00	1.49
FLORIDA	1	0.06	0.00	0.06	3	0.90	0.00	0.90	1	0.62	0.00	0.62	4	3.39	67.00	70.39
GEORGIA	49	2.82	0.09	2.92	46	9.80	0.13	9.94	5	1.85	0.00	1.85	4	4.54	1.22	5.76
KENTUCKY	1	0.15	0.00	0.15	6	0.82	0.00	0.82	2	1.49	0.00	1.49	0	0.00	0.00	0.00
MISSISSIPPI	68	4.31	0.06	4.37	106	21.91	0.52	22.43	25	15.10	1.50	16.60	15	24.12	7.37	31.49
NORTH CAROLIN	17	1.07	0.00	1.08	15	2.76	0.18	2.95	2	1.05	0.00	1.05	0	0.00	0.00	0.00
SOUTH CAROLIN	18	0.90	0.07	0.97	38	9.01	0.06	9.08	12	6.68	0.98	7.67	4	8.46	0.45	8.92
TENNESSEE	9	0.44	0.02	0.47	15	3.19	0.03	3.23	2	1.08	0.21	1.30	0	0.00	0.00	0.00
REGION 4	170	10.22	0.27	10.50	273	58.85	1.20	60.06	63	36.47	2.84	39.31	28	42.02	76.05	118.08
ILLINOIS	121	7.85	0.03	7.89	123	23.91	0.37	24.28	10	5.35	0.09	5.45	2	3.50	1.47	4.98
INDIANA	17	1.23	0.00	1.23	22	4.23	0.10	4.34	5	3.14	0.00	3.14	0	0.00	0.00	0,00
MICHIGAN	58	4.08	0.00	4.08	104	19.56	0.37	19.93	19	11.80	1.01	12.81	7	25.92	27.01	52.94
MINNESOTA	161	7.77	0.05	7.82	78	14.08	1.77	15.86	6	2.83	0.62	3.46	6	6.63	1.18	7.81
OHIO	5	0.30	0.00	0.30	28	5.54	0.24	5.79	5	3.07	0.00	3.07	0	0.00	0.00	0.00
WISCONSIN	144	6.83	0.15	6.98	47	8.06	0.86	8.93	9	5.32	0.55	5.87	3	2.08	1.58	3.67
REGION 5	506	28.08	0.24	28.32	402	75.41	3.74	79.16	54	31.54	2.29	33.84	18	38.15	31.27	69.42

DESIGN AND FLOW CHARACTERISTICS OF MUNICIPAL WASTE-WATER LAGOONS IN THE UNITED STATES

USEPA	DESIGN FLOW < 0.1 MGD				DESIGN FLOW 0.1 - 0.49 MGD				DESIGN FLOW 0.5 - 1.0 MGD				DESIGN FLOW > 1.0 MGD			
REGION/STATE	# OF FAC	FLOW,MGD DOMES	INDUS	TOTAL	# OF FAC	FLOW,MGD DOMES	INDUS	TOTAL	# OF FAC	FLOW,MGD DOMES	INDUS	TOTAL	# OF FAC	FLOW,MGD DOMES	INDUS	TOTAL
ARKANSAS	61	4.09	0.00	4.09	88	18.25	0.19	18.45	22	14.86	0.30	15.16	19	36.05	4.74	40.79
LOUISIANA	36	2.29	0.01	2.31	68	16.14	0.05	16.20	26	17.72	1.13	18.86	14	33.18	3.08	36.27
NEW MEXICO	32	1.48	0.00	1.48	13	2.86	0.00	2.86	4	1.98	0.00	1.98	2	5.29	0.69	5.99
OKLAHOMA	220	11.55	0.03	11.58	85	16.68	0.11	16.79	14	8.58	0.31	8.90	5	7.54	4.04	11.59
TEXAS	113	78.64	0.00	78.64	92	29.15	0.03	29.19	10	6.40	0.46	6.87	6	24.92	3.93	28.85
REGION 6	462	98.07	0.04	98.12	346	83.11	0.40	83.52	76	49.57	2.22	51.79	46	107.00	16.51	123.51
IOWA	296	18.82	0.12	18.95	88	14.98	0.14	15.13	3	1.85	0.00	1.85	0	0.00	0.00	0.00
KANSAS	266	11.16	0.00	11.16	83	17.49	0.29	17.79	4	2.64	0.00	2.65	4	7.82	0.29	8.12
MISSOURI	182	9.19	0.02	9.22	97	19.55	0.92	20.47	24	15.30	1.04	16.34	7	12.13	1.19	13.33
NEBRASKA	224	7.02	0.00	7.02	35	8.47	0.26	8.73	2	1.24	0.00	1.24	3	6.66	0.77	7.44
REGION 7	968	46.20	0.15	46.35	303	60.50	1.63	62.13	33	21.06	1.05	22.11	14	26.61	2.27	28.89
COLORADO	85	4.61	0.00	4.61	51	11.80	0.11	11.92	16	12.30	0.39	12.70	4	14.28	0.00	14.28
MONTANA	74	3.08	0.00	3.08	42	9.36	0.00	9.36	10	6.18	0.00	6.18	3	3.30	0.69	4.00
NORTH DAKOTA	227	6.71	0.00	6.72	37	6.88	0.04	6.93	4	2.73	0.00	2.73	10	17.00	4.01	21.01
SOUTH DAKOTA	173	6.94	0.00	6.95	50	9.23	0.38	9.62	4	2.29	0.00	2.29	1	2.33	0.00	2.33
UTAH	23	1.18	0.00	1.18	29	7.10	0.18	7.29	4	2.68	0.00	2.68	5	23.35	0.29	23.65
WYOMING	50	1.68	0.00	1.68	22	4.89	0.00	4.89	0	0.00	0.00	0.00	5	11.57	0.00	11.57
REGION 8	632	24.24	0.01	24.25	231	49.28	0.75	50.04	38	26.21	0.39	26.61	28	71.86	5.01	76.87
ARIZONA	27	1.24	0.00	1.25	24	5.80	0.00	5.80	15	10.03	0.09	10.13	7	16.21	1.73	17.95
CALIFORNIA	74	19.58	0.00	19.58	76	15.99	0.49	16.48	30	16.88	2.35	19.24	29	63.94	31.07	95.01
HAWAII	1	0.04	0.00	0.04	0	0.00	0.00	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0.00
NEVADA	20	0.98	0.00	0.98	9	1.82	0.00	1.82	6	2.99	0.00	2.99	3	8.71	0.00	8.71
AMERICAN SAMO	0	0.00	0.00	0.00	0	0.00	0.09	0.06	1	0.64	0.00	0.64	0	0.00	0.00	0.00
GUAM	0	0.00	0.00	0.00	1	0.11	0.00	0.11	1	0.78	0.00	0.78	0	0.00	0.00	0.00
PAC. TR. TERR	1	0.09	0.00	0.09	0	0.00	0.00	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0.00
REGION 9	123	21.96	0.00	21.96	110	23.74	0.49	24.24	53	31.35	2.45	33.80	39	88.87	32.81	121.69
ALASKA	9	0.25	0.00	0.25	3	0.69	0.00	0.69	0	0.00	0.00	0.00	2	2.89	0.00	2.89
IDAHO	59	2.85	0.00	2.85	26	9.80	0.18	9.99	5	3.42	0.00	3.42	5	12.81	0.00	12.81
OREGON	30	10.00	0.00	10.00	29	6.00	0.00	6.00	7	4.88	0.00	4.88	9	23.47	36.31	59.79
REGION 10	133	15.04	0.00	15.04	83	24.42	0.23	24.66	23	15.38	1.05	16.44	32	99.64	43.55	143.19
US TOTALS:	3066	248.43	0.87	249.30	1829	393.61	9.64	403.00	362	223.39	14.95	238.09	219	489.61	217.88	707.25

APPENDIX 3.3

CONVERSION OF FLOW RATES TO AREAS

APPENDIX 3.3

CONVERSION OF LAGOON FLOW RATES TO AREAS

For use in this study, the flow rate distribution in Table 3-1 of the text has been converted to an area distribution using the equation below:

$A = 3.0334\ (t/d)(Q)$

where 3.0334 is a factor for converting the units of the right hand side (mgd, feet and days) into units of acres, and

A = lagoon area (acres)
t = hydraulic retention time (days)
d = lagoon depth (feet)
Q = design flow (mgd)

Values for hydraulic retention time and depth were assumed based on typical ranges for facultative lagoons (25-180 days and 4-8 feet, respectively) obtained from the USEPA's Design Manual for Municipal Wastewater Stabilization Ponds (1). For median values of 102.5 days and 6 feet, the above equation becomes:

$A = 51.82(Q)$

APPENDIX 3.4

WASTEWATER CHARACTERISTICS

APPENDIX 3.4

TABLE 3.4-1

TYPICAL COMPOSITION OF UNTREATED DOMESTIC WASTEWATER

Pollutant or Pollutant Parameter	Concentration (mg/l)		
	Strong	Medium	Weak
Solids, total:	1,200	720	350
Dissolved, total	850	500	250
Fixed	525	300	145
Volatile	325	200	105
Suspended, total	350	220	100
Fixed	75	55	20
Volatile	275	165	80
Settleable solids, mL/L	20	10	5
Biochemical oxygen demand, 5-day, 20°C (BOD_5, 20°C)	400	220	110
Total organic carbon (TOC)	290	160	80
Chemical oxygen demand (COD)	1,000	500	250
Nitrogen (total as N):	85	40	20
Organic	35	15	8
Free ammonia	50	25	12
Nitrites	0	0	0
Nitrates	0	0	0
Phosphorus (total as P):	15	8	4
Organic	5	3	1
Inorganic	10	5	3
Chlorides[a]	100	50	30
Alkalinity (as $CaCo_3$)[a]	200	100	50
Grease	150	100	50

Source: Reference 5.

[a] Values for alkalinity and chlorides will be increased by the amount found in the domestic water supply.

APPENDIX 3.4

TABLE 3.4-2

EPA'S TOXIC (PRIORITY) POLLUTANTS[a]

Class/Pollutant

VOLATILE ORGANIC COMPOUNDS

- Acrolein
- Acrylonitrile
- Benzene
- Toluene
- Ethylbenzene
- Carbon Tetrachloride
- Chlorobenzene
- 1,2-Dichloroethane
- 1,1,1-Trichloroethane
- 1,1-Dichloroethane
- 1,1-Dichloroethylene
- 1,1,2-Trichloroethane
- 1,1,2,2-Tetrachloroethane
- Chloroethane
- 2-Chloroethyl Vinyl Ether
- Chloroform
- 1,2-Dichloropropane
- 1,3-Dichloropropene
- Methylene Chloride
- Methyl Chloride
- Methyl Bromide
- Bromoform
- Dichlorobromomethane
- Chlorodibromomethane
- Tetrachloroethylene
- Trichloroethylene
- Vinyl Chloride
- 1,2-trans-Dichloroethylene

ACID EXTRACTABLE ORGANIC COMPOUNDS

- Phenol
- 2-Nitrophenol
- 2,4-Dichlorophenol
- 4-Nitrophenol
- 2,4-Dimethylphenol
- Pentachlorophenol
- p-Chloro-m-cresol
- 2-Chlorophenol
- 2,4-Dinitrophenol
- 2,4,6-Trichlorophenol
- 4,6-Dinitro-o-cresol

26 PESTICIDES/PCBs

- alpha-Endosulfan
- beta-Endosulfan
- Endosulfan Sulfate
- alpha-BHC
- beta-BHC
- gamma-BHC (Lindane)
- delta-BHC
- Aldrin
- Dieldrin
- 4,4'-DDE
- 4,4'-DDD
- 4,4'-DDT
- Endrin
- Endrin Aldehyde
- Heptachlor
- Heptachlor Epoxide
- Chlordane
- Toxaphene
- Aroclor 1016
- Aroclor 1221
- Aroclor 1232
- Aroclor 1242
- Aroclor 1248
- Aroclor 1254
- Aroclor 1260
- 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)

APPENDIX 3.4

TABLE 3.4-2, Continued
EPA'S TOXIC (PRIORITY) POLLUTANTS[a]

Class/Pollutant
BASE/NEUTRAL EXTRACTABLE ORGANIC COMPOUNDS
1,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
Hexachloroethane
Hexachlorobutadiene
Hexachlorobenzene
1,2,4-Trichlorobenzene
bis(2-Chloroethoxy)methane
Naphthalene
2-Chloronaphthalene
Isophorone
Nitrobenzene
2,4-Dinitrotoluene
2,6-Dinitrotoluene
4-Bromophenyl Phenyl Ether
bis(2-Ethylhexyl)phthalate
Di-n-octyl Phthalate
Dimethyl Phthalate
Diethyl Phthalate
Di-n-butyl Phthalate
Acenaphthylene
Acenaphthene
Butyl Benzyl Phthalate
Fluorene
Fluoranthene
Chrysene
Pyrene
Phenanthrene
Benzo(a)anthracene
Benzo(b)fluoranthene
Benzo(k)fluoranthene
Benzo(a)pyrene
Indeno(1,2,3-c,d)pyrene
Dibenzo(a,h)anthracene
Benzo(g,h,i)perylene
4-Chlorophenyl Phenyl Ether
3,3'-Dichlorobenzidine
Benzidine
bis(2-Chloroethyl)ether
1,2-Diphenylhydrazine
Hexachlorocyclopentadiene
N-Nitrosodiphenylamine
N-Nitrosodimethylamine
N-Nitrosodi-n-propylamine
bis(2-Chloroispropyl)ether
Anthracene
13 METALS
Antimony
Arsenic
Beryllium
Cadmium
Chromium
Copper
Lead
Mercury
Nickel
Selenium
Silver
Thallium
Zinc
OTHER
Total Cyanides
Asbestos (fibrous)

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[a] Designated pursuant to Section 307(a)(1) of the Clean Water Act.

APPENDIX 3.4

TABLE 3.4-3

COMMON CONSUMER PRODUCTS AND THEIR HOUSEHOLD SOURCES

Household Source	Consumer Product
Automatic Dishwasher Waste	Detergents Silver polish
Bath and Shower Waste	Soaps (perfumed) Medicinal ointments Shampoo Disinfectants Cosmetics (makeup, antiperspirant, hair dyes)
Bathroom Sink Waste	Medicine Soaps Disinfectants Cosmetics Shampoo Cleaner
Garbage Disposal	Pesticides (from washing produce) Deoderizer
Kitchen Sink	Hand soaps and cleaners Polish Pesticides Cosmetics Cleaners
Laundry Waste	Polish (laundered clothes soiled with polish) Fabric adhesives Dyes and textile coatings Medicinal ointments Laundry products Pesticides and insecticides Disinfectants Bleach and starch
Toilet Flush Waste	Medicinal ointments Disinfectants Deoderizer Cleaner
Utility Sink Waste	Preservatives and dyes Polish Photographic products Paint products Pesticides Cleaners Bleach

Source: Reference 6

APPENDIX 3.4

TABLE 3.4-4

PRIORITY POLLUTANTS IN HOUSEHOLD WASTES

Household Source	Priority Pollutant
Automatic Dishwasher Waste	Phenol*
	Benzene*
	Toluene*
	2,4,6-Trichlorophenol*
	Silver*
Bath and Shower Waste	Phenol*
	Benzene*
	Naphthalene*
	1,2-Dichloroethylene
	Diethylphthalate*
	Dimethylphthalate*
	Toluene*
	2,4,6-Trichlorophenol*
	2-Chlorophenol*
	2,4-Dimethylphenol
	Fluoroanthene
	PAHs
	2,4-Dichlorophenol
	Antimony*
	Cadmium*
	Copper*
	Lead*
	Mercury*
	Nickel*
	Selenium
	Silver*
	Zinc*
Bathroom Sink Waste	Phenol*
	Toluene*
	Benzene*
	2,4,6-Trichlorophenol*
	2-Chlorophenol*
	p-Chloro-m-cresol
	2,4-Dimethylphenol
	Fluoranthene
	Naphthalene*
	PAHs
	Diethylphthalate*
	Dimethylphthalate*
	Antimony*
	Cadmium*
	Copper*
	Lead*
	Mercury*
	Silver*
	Zinc*
	Arsenic*

APPENDIX 3.4

TABLE 3.4-4, Continued

PRIORITY POLLUTANTS IN HOUSEHOLD WASTES

Household Source	Priority Pollutant
Garbage Disposal Waste	1,4-Dichlorobenzene*
	Aldrin*
	Dieldrin*
	Chlordane
	Arsenic*
	Cadmium*
	Chromium*
	Copper*
	Lead*
	Mercury*
	Zinc*
Kitchen Sink Waste	Phenol*
	Toluene*
	1,2-Dichlorobenzene*
	Tetrachloroethylene
	1,2-Dichloroethylene
	Diethylphthalate*
	Dimethylphthalate*
	1,2-Dichloroethane
	1,1,2,2-Tetrachloroethane
	1,2-Dichloropropane
	1,2-Dichloropropylene
	Isophorone
	Trichloroethylene*
	Carbon Tetrachloride
	Arsenic*
	Cadmium*
	Chromium*
	Copper*
	Lead*
	Mercury*
	Zinc*
	Antimony*
	Nickel*
	Silver*
Laundry Waste	2,4,6-Trichlorophenol
	1,2-Dichlorobenzene*
	Benzene*
	Phenol*
	1,4-Dichlorobenzene*
	2,4-Dimethylphenol
	Naphthalene*
	1,1,1-Trichloroethane*
	1,1,2,2-Tetrachloroethane
	1,3-Dichlorobenzene

APPENDIX 3.4

TABLE 3.4-4, Continued

PRIORITY POLLUTANTS IN HOUSEHOLD WASTES

Household Source	Priority Pollutant
Laundry Waste, Continued	Nitrobenzene
	Tetrachloroethylene*
	Diethylphthalate*
	Dimethylphthalate*
	Chlorophenol*
	Arsenic*
	Cadmium*
	Chromium*
	Copper*
	Lead*
	Mercury*
	Zinc*
Toilet Flush Waste	Benzene*
	Phenol*
	2,4,6-Trichlorophenol*
	2-Chlorophenol*
	1,2-Dichlorobenzene*
	1,3-Dichlorobenzene
	1,4-Dichlorobenzene*
	1,1,1-Trichloroethane*
	1,1,2-Trichloroethane
	Naphthalene*
	Trichloroethylene*
	1,2-Dichloroethane
	Antimony*
	Copper*
	Mercury*
	Zinc*
	Chromium*
Utility Sink Waste	1,1,1-Trichloroethane*
	1,1,2-Trichloroethane
	1,2-Dichlorobenzene*
	2,4,6-Trichlorophenol*
	Antimony*
	Arsenic*
	Cadmium*
	Copper*
	Lead*
	Mercury*
	Nickel*
	Scandium*
	Zinc*
	Silver*

Source: Reference 6
*Most commonly found (14 organics, 9 metals).

APPENDIX 3.5

LAGOON SAMPLING PROGRAM

ATTACHMENT B

LAGOON SAMPLING AND ANALYTICAL PROCEDURES

The Publicly Owned Treatment Works (POTW) Lagoon Study sampling program was conducted at nine domestic lagoon and 12 municipal lagoon systems as identified in the final letter report.[a] Priority pollutants[b] and selected nonconventional water quality parameters (total organic carbon, ammonia nitrogen, oxidized nitrogen, total solids (sludges), and chloride) were sampled at each site. U.S. Environmental Protection Agency (EPA), Brown and Caldwell (BC) and Robert E. Lee and Associates, Inc. (REL) personnel participated in the sampling program. Analytical work was performed at EPA laboratories in Annapolis, Maryland (Central Regional Laboratory) and Athens, Georgia, (Environmental Services Division Laboratory) and the Robert E. Lee and Associates, Inc. Analytical Laboratory in Green Bay, Wisconsin. A site sampling and analysis summary is presented in Table 1.

Sampling Procedures

Sampling of the 21 facilities was performed during two periods. The nine domestic lagoon systems (plus the Mandan, ND municipal/industrial lagoon system[c]) were sampled by EPA Regions III and IV between August and November, 1985. The 11 other municipal/industrial lagoons were sampled by EPA Region IV, REL and BC during July and August, 1986.

The domestic sampling program was developed by EPA Headquarters in Washington and concentrated on lagoon systems with monitoring wells. Based on information gained by BC from observations of sampling activities performed by Region IV at three Michigan sites typical sampling procedures used for the domestic lagoon study are presented below.

Influent automatic composite samplers were used to obtain 6 to 24 hour composites of all contaminants except volatile organics, cyanide and total phenolics. Grab samples were collected for these contaminants. Volatile organic influent samples were collected in triplicate. Lagoon liquid, effluent, sludge and monitoring well grab samples were also collected. Typically, one upgradient and three down gradient monitoring wells were sampled. Sampling procedures used (e.g., minimizing aeration of volatile organics and flushing monitoring wells three times prior to sampling) were based on standard EPA sampling protocol. If a monitoring well dried up during baling operations the well was allowed to recover overnight prior to sampling. Teflon balers were used for baling and sample collection. Field and equipment blanks were collected at each site.

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[a] In addition, data from the Everett, WA and Muskegon, MI municipal/industrial lagoon systems are used in the study.

[b] Except dioxin.

[c] The Mandan, ND lagoon system was initially classified as a domestic lagoon.

For the municipal/industrial lagoon sampling program, samples obtained by REL and BC at nine sites were collected in accordance with procedures specified in the Quality Assurance Project Plan submitted to EPA as part of the Revised Work Plan for Work Assignment 2-7 dated July 30, 1986.

For the two municipal/industrial lagoons sampled by EPA Region IX, sampling activities were conducted in accordance with the Engineering Support Branch Standard Operating Procedures and Quality Assurance Manual, U.S. Environmental Protection Agency, Region IV, Environmental Services Division, dated April 1, 1986.

Analytical Procedures

Analytical methods and quality assurance procedures used during the study are documented as follows:

1. EPA Central Regional Laboratory--memo from Joseph L. Slayton, CRL Chemist to Water Gilbert, EPA Headquarters dated January 28, 1986.

2. REL Analytical Laboratory--Quality Assurance Project Plan for Work Assignment 2-7 (submitted to EPA with Revised Work Plan dated July 30, 1986).

3. EPA Environmental Services Division Laboratory--EPA Region IV Analytical Support Branch Operations and Quality Control Manual, dated June 1985.

Table 2 summarizes analytical detection limits for both liquid and sludge samples from the three laboratories participating in the sampling program and for the independent data collected from the Muskegon, MI and Everett, WA facilities. Detection limit ranges shown in Table 2 represent both variances in specific contaminants within the identified contaminant category and variances between samples. Typically, for the majority of contaminants, detection limits were near the lower limit of the range. Table 3 identifies detection limits for each contaminant analyzed by REL. There was greater variance in detection limits for individual compounds sampled by EPA. The respective EPA laboratories supplied detection limits for the contaminants as part of raw data sheets for each site transmitted to EPA headquarters.

Analytical methods[1,2,3,4] were similar at all laboratories except those for volatile (purgeable) and extractable organics. The EPA laboratories used gas chromatograph/mass spectrometer (GC/MS) methods, EPA Method 624 for volatile and Method 625 for extractable organics. The REL laboratory used principally GC and liquid chromatography (LC) methods with specific detectors in accordance with EPA Methods 601, 602, 603, 604, 605, 606, 607, 609, 610, 611 and 612.

Metals concentrations were measured with element specific spectroscopic analytical methods. Cyanide was analyzed spectrophotometrically, while total phenols were determined via distillation and colorimetric methods.

Quality control and assurance procedures used during the study included spike samples, duplicates and participation in external performance audit sample surveys with EPA Cincinnati. Summary data used in the study were corrected for water and equipment blank contamination.[5]

REFERENCES

1. "Standard Methods for the Examination of Water and Wastewater," APHA-AWWA-WPCF, 16th Edition, 1985.
2. "Test Methods for Evaluating Solid Waste--Physical/Chemical Methods," EPA/SW-846, United States Environmental Protection Agency, 2nd Edition, revised 1985.
3. "Methods for the Chemical Analysis of Water and Wastes," EPA-600/4-79-020, United States Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Cincinnati, Ohio, 1979.
4. "Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater," EPA-600/4-82-047, United States Environmental Protection Agency, July 1982.
5. "Handbook for Analytical Quality Control in Water and Wastewater Laboratories," EPA-600/4-79-019, United States Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Cincinnati, Ohio, 1979.

Table 1 POTW Lagoon Study Sample Collection and Analyses Summary

Site	Lagoon category	Samples collected					Sample collection	Chemical analysis
		Influent	Effluent	Lagoon liquid	Monitoring wells	Sludge		
Honeybrook, PA	Domestic	x		x	x	x	EPA Region III	EPA CRL[a]
Britton Village, MI	Domestic	x	x	x	x	x	EPA Region V	EPA CRL
Potterville, MI	Domestic	x	x	x	x	x	EPA Region V	EPA CRL
Standish, MI	Domestic	x	x	x	x		EPA Region V	EPA CRL
Minot, ND	Domestic	x	x	x	x	x	EPA Region III	EPA CRL
McVille, ND	Domestic	x		x	x	x	EPA Region III	EPA CRL
Laramie, WY	Domestic	x	x	x	x	x	EPA Region III	EPA CRL
Lander, WY	Domestic	x	x	x	x	x	EPA Region III	EPA CRL
Buffalo, WY	Domestic	x		x	x	x	EPA Region III	EPA CRL
Mandan, ND	Municipal/ industrial	x	x	x	x	x	EPA Region III	EPA CRL
Hebron, IL	Municipal/ industrial	x	x		x	x	REL[b]	REL
Dexter, MO	Municipal/ industrial	x	x			x	REL	REL
Atkins, AK	Municipal/ industrial	x	x			x	REL	REL
Hattisburg, MT/MS	Municipal/ industrial	x	x	x		x	REL	REL
Alexandria, LA	Municipal/ industrial	x	x			x	REL	REL
Glendive, MT	Municipal/ industrial	x	x			x	REL	REL
Scottsbluff, NE	Municipal/ industrial	x	x			x	REL	REL
Minong, WI	Municipal/ industrial	x	x			x	REL	REL
Ridgecrest, CA	Municipal/ industrial	x	x	x		x	BC[c]	REL
Andrews, SC	Municipal/ industrial	x	x			x	EPA Region IV	EPA Athens, GA[d]
Pickens, SC	Municipal/ industrial	x	x			x	EPA Region IV	EPA Athens, GA

[a] EPA Central Regional Laboratory--Annapolis, MD.

[b] Robert E. Lee and Associates.

[c] Brown and Caldwell.

[d] EPA Environmental Science Division Laboratory, Athens, GA.

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Table 2 Summary of Analytical Detection Limits

Contaminant category	Anapolis, MD Laboratory		Athens, GA Laboratory		REL, Inc. Laboratory	Muskegon, MI		Everett, WA
	Liquid, ug/l	Sludge mg/kg[a]	Liquid, ug/l	Sludge, mg/kg[b]	Liquid,[c] ug/l	Liquid, ug/l	Sludge, ug/kg[b]	Liquid,[d] ug/l
Organics								
Volatile	1	0.005-0.01	5	0.03-0.3	0.1-1.8	1-10	10-100	5-20
Extractable	10-200	10-33.3	50-100	46-250	0.1-16	1-10	5-10	550
Pesticides/PCB's	0.002-0.15	0.02-1.5	0.03-27	0.06-7.7	0.003-0.083	0.1-1	1-10	0.002-20
Total phenolics	10	-	-	-	5	-	-	-
Inorganics								
Metals	0.2-50	0.01-10	10-200	3-12	0.05-8	10-30	-	10-25
Cyanide	20	-	-	-	3	-	-	-
TOC	1,000	-	-	-	100	-	-	-
NH_3-N	40	-	0.10	-	50	-	-	-
NO_x-N	40	-	0.05	-	5	-	-	-
Chloride	-	-	45	-	100	-	-	-

[a] Wet weight basis.

[b] Dry weight basis.

[c] Sludge detections limits approximately 20 times greater than liquid limits (expressed as ug/kg--dry weight basis).

[d] Only metals analyzed in sludge, detection limits were approximately 2 mg/kg.

ROBERT E. LEE & ASSOCIATES
USEPA WASTEWATER SAMPLING PROJECT
JOB NUMBER: 950007
DETECTION LIMITS[a]

Table 3. REL Analytical Detection Limit Summary

PARAMETER	CONCENTRATION (UG/L)	PARAMETER	CONCENTRATION (UG/L)	PARAMETER	CONCENTRATION (UG/L)
TOTAL ORGANIC CARBON	<100	4-CHLORO-3-METHYLPHENOL	<0.36	1,2-DICHLOROBENZENE	<1.14
AMMONIA-N	<50	2-CHLOROPHENOL	<0.31	1,3-DICHLOROBENZENE	<1.19
NITRATE/NITRITE-N	<5	2,4-DICHLOROPHENOL	<0.39	1,4-DICHLOROBENZENE	<1.34
CHLORIDE	<100	2,4-DIMETHYLPHENOL	<0.32	HEXACHLOROBENZENE	<0.05
		2,4-DINITROPHENOL	<13	HEXACHLOROBUTADIENE	<0.34
ANTIMONY	<5	2-METHYL-4,6-DINITROPHENOL	<16	HEXACHLOROCYCLOPENTADIENE	<0.34
ARSENIC	<0.05	2-NITROPHENOL	<0.45	HEXACHLOROETHANE	<0.03
BARIUM	<8	4-NITROPHENOL	<2.8	1,2,4-TRICHLOROBENZENE	<0.05
CADMIUM	<3	PENTACHLOROPHENOL	<7.4	1,2-DIPHENYL HYDRAZINE	
CHROMIUM	<3	PHENOL	<0.14		
COPPER	<3	2,4,6-TRICHLOROPHENOL	<0.64	ALDRIN	<0.004
LEAD	<3			A-BHC	<0.003
MERCURY	<0.2	BIS(2-ETHYLHEXYL) PHTHALATE	<2.0	B-BHC	<0.006
NICKEL	<3	BUTYL BENZYL PHTHALATE	<0.34	S-BHC	<0.009
SELENIUM	<0.2	DI-N-BUTYL PHTHALATE	<0.36	G-BHC	<0.004
SILVER	<5	DIMETHYL PHTHALATE	<0.29	CHLORDANE	*
THALLIUM	<8	DI-N-OCTYL PHTHALATE	<3.0	4,4'-DDD	<0.012
ZINC	<0.1			4,4'-DDE	<0.004
		BENZIDINE	<0.08	4,4'-DDT	<0.012
CYANIDE	<5	3,3'-DICHLOROBENZIDINE	<0.13	DIELDRIN	<0.002
				ENDOSULFAN I	<0.014
TOTAL PHENOLICS	<5	N-NITROSODIMETHYLAMINE	<0.15	ENDOSULFAN II	<0.004
		N-NITROSODIPHENYLAMINE	<0.81	ENDOSULFAN SULFATE	<0.066
BROMODICHLOROMETHANE	<0.10	N-NITROSODI-N-PROPYLAMINE	<0.46	ENDRIN	<0.006
BROMOFORM	<0.20			ENDRIN ALDEHYDE	<0.023
BROMOMETHANE	<1.18	2,4-DINITROTOLUENE	<0.02	HEPTACHLOR	<0.003
CARBON TETRACHLORIDE	<0.12	2,6-DINITROTOLUENE	<0.01	HEPTACHLOR EPOXIDE	<0.083
CHLOROBENZENE	<0.26	ISOPHORONE	<5.7	TOXAPHENE	*
CHLOROETHANE	<0.52	NITROBENZENE	<3.6	PCB-1016	*
2-CHLOROETHYLVINYL ETHER	<0.13			PCB-1221	*
CHLOROFORM	<0.05	ACENAPHTHENE	<1.8	PCB-1232	*
CHLOROMETHANE	<0.08	ACENAPHTHYLENE	<2.3	PCB-1242	*
DIBROMOCHLOROMETHANE	<1.81	ANTHRACENE	<0.66	PCB-1248	*
1,1-DICHLOROETHANE	<0.07	BENZO (A) ANTHRACENE	<0.03	PCB-1254	*
1,2-DICHLOROETHANE	<0.03	BENZO (A) PYRENE	<0.023	PCB-1260	*
1,1-DICHLOROETHENE	<0.13	BENZO (B) FLUORANTHENE	<0.018		
TRANS-1,2-DICHLOROETHENE	<0.10	BENZO (GHI) PERYLENE	<0.076		
1,2-DICHLOROPROPANE	<0.04	BENZO (K) FLUORANTHENE	<0.017		
CIS-1,3-DICHLOROPROPENE	<0.20	CHRYSENE	<0.15		
TRANS-1,3-DICHLOROPROPENE	<0.34	DIBENZO (A,H) ANTHRACENE	<0.03		
METHYLENE CHLORIDE	<0.28	FLUORANTHENE	<0.21		
1,1,2,2-TETRACHLOROETHANE	<0.03	FLUORENE	<0.21		
TETRACHLOROETHENE	<0.03	INDENO (1,2,3-CD) PYRENE	<0.043		
1,1,1-TRICHLOROETHANE	<0.03	NAPHTHALENE	<1.8		
1,1,2-TRICHLOROETHANE	<0.03	PHENANTHRENE	<0.64		
TRICHLOROETHENE	<0.12	PYRENE	<0.27		
VINYL CHLORIDE	<0.18				
		BIS (2-CHLOROETHYL) ETHER	<0.3		
BENZENE	<0.2	BIS (2-CHLOROETHOXY) METHANE	<0.5		
ETHYL BENZENE	<0.2	BIS (2-CHLOROISOPROPYL) ETHER	<0.8		
TOLUENE	<0.2	4-BROMOPHENYL PHENYL ETHER	<2.3		
		4-CHLOROPHENYL PHENYL ETHER	<3.9		
ACROLEIN	<0.6	2-CHLORONAPHTHALENE	<0.94		
ACRYLONITRILE	<0.8				

* MULTIPLE PEAK RESPONSE-DETECTION LIMIT APPROXIMATELY 0.1 PPB

[a] Liquid detection limits--Sludge detection limits approximately 20 times greater, expressed as ug/Kg (dry weight basis)

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DATE : January 28, 1986

SUBJECT: Central Regional Laboratory Quality Assurance Procedures Employed During the Analysis of Construction Grants Samples

FROM : Joseph L. Slayton (3ES21) JS
Chemist

TO : Walter Gilbert (WH-595)

The quality assurance procedures employed during the analysis of the Construction Grants samples have been summarized by parameter group.

General

The Central Regional Laboratory participates each year in four external performance audit sample surveys. These include unknown audit samples for the SDWA; NPDES; Superfund and RCRA programs. The laboratory has a full time quality assurance officer and technician. Quarterly performance checks are routinely performed to assure adequate operational of balances; spectrophotometers; pH meters and other critical insturmentation.

Phenol

A duplicate (precision) and spike (accuracy) sample were analyzed every tenth sample. A check standard was analyzed in the middle and end of each set of samples analyzed. An audit sample (EPA-Cincinnati provided external standard) was analyzed at the beginning of each set of samples analyzed. The calibration curve consisted of six standards.

Cyanide

A duplicate (precision) and spike (recovery) sample were analyzed after every tenth sample. A check standard was analyzed after every three or four samples. An audit (EPA-Cincinnati) was analyzed at the beginning of each analysis set. The calibration curve consisted of six standards and was prepared for each set of samples analyzed.

Total Carbon

A duplicate (precision) and spike (recovery) sample were analyzed after every tenth sample. A check standard was analyzed after every tenth sample. An audit (EPA-Cincinnati) sample was analyzed after every tenth sample. The calibration curve consisted of seven standards.

Nitrite, Nitrate, Ammonia

A duplicate (precision) and spike (recovery) sample were analyzed after every tenth sample. This was followed directly by a check standard. An audit sample (EPA-Cincinnati) was analyzed at the beginning of each set of analysis. The calibration curve consisted of seven standards.

Chloride

A duplicate (precision) and spike (recovery) sample were analyzed after every tenth sample. A check standard on audit sample (EPA-Cincinnati) was analyzed at the beginning of each analysis. The calibration curve consisted of at least seven standards.

Mercury

A duplicate (precision), a digestion duplicate, a check standard and a spiked sample (recovery) were analyzed after every tenth sample. An audit sample (EPA-Cincinnati) was analyzed at the beginning of each set of samples analyzed, for each type of matrix. The calibration curve consisted of at least six standards.

Metals

A standard curve composed of five or six standards for each metal was analyzed to calibrate the instruments. In addition, the instrument was previously autozeroed. After the standardization, a performance audit sample (EPA provided external standard) was routinely analyzed to confirm the accuracy of the instrument (± 10% required audit performance). This performance check was followed by the analysis of a reagent blank, a digestion blank and corresponding field blanks. Ten percent of the samples were analyzed in duplicate. Also a check standard was analyzed every ten samples with the required limits of ± 10%. For samples analyzed by the furance technique every sample was spiked at least once. If this single spike result was not found to give 85-115% recovery, then the Method of Standard Additions was employed using two additional spikes.

Extractables Organic Compounds GC/MS

Before acquisition of any samples the mass spectrometer was calibrated using FC43. The calibration was verified by obtaining the spectra of a known compound (DFTPP). All mass assignments and relative abundances were found to be in acceptable ranges or the instrument was adjusted until suitable spectra of the known were obtained. Immediately before analysis each sample was spiked with an internal standards mixture containing six compounds including D10-phenanthrene. All quantitation or estimates of concentration were made in comparison to the nearest internal standards. Mixed standards of extractable priority pollutants and Hazardous Compound List Substances (EPA-RTP provided) were analyzed at multiple concentration levels before each group of samples. The relative response of each compound versus the nearest internal standard was determined for use in quantitation. For each group of samples extracted (≤ 20 samples) a method blank was prepared and examined for laboratory introduced contamination. In addition, field blanks were

Extractables Organics (GC/MS) (Con't)

analyzed and all sample values were corrected for any blank contamination. Each sample was spiked with a mixture of surrogate compounds (six) prior to extraction and analysis. The recovery for each was determined to check for matrix effect. For each group of samples extracted (≤ 20), an aliquot of sample was spiked with a priority pollutant cocktail containing twelve representative target compounds and carried through the extraction and GC/MS analysis. The recovery for each compound was determined to check for matrix effect.

Pesticides

The instruments are calibrated before each set of samples with varified standards (EPA-Cincinnati or proven equivalent). The samples are spiked with EPA reference PCB/chlordane mixtures). A duplicate sample is analyzed with each set of samples. A degradation check standard for Endrin and DDT was analyzed with each set of samples to assure satisfactory column performance. Field and reagent blanks were analyzed to varify the absence of pesticide contamination.

Volatile Organic Compounds GC/MS

The QA procedures included on a daily basis an initial instrument blank followed by a method blank and standards (EPA or EPA varified).

Incorporated in the first method blank was the analysis of 4-Bromo-1-Fluorobenzene (BFB) as a Mass Spectral Criteria Compound. If the spectra of BFB did not meet the criteria specified in Method 624 the Mass Spectrometer would be recalibrated using Perfluorotributylamine (FC43) until the criteria was met.

The analysis of field blanks and additional method blanks followed the analysis of standards.

The following additional QA procedures were employed: At least one duplicate analysis was performed for each batch of samples. At least one matrix spike was performed for each batch of samples. In addition, samples that had high contamination were followed by method blanks.

JLS:ad

APPENDIX 3.5

TABLE 3.5-1

SUMMARY OF DOMESTIC LAGOON SAMPLING RESULTS

Pollutant Category/ Pollutant	Lagoon Influent		Lagoon Effluent[a]		Lagoon Sludge[b]		Monitoring Wells	
	Min	Max	Min	Max	Min	Max	Min	Max
VOLATILES	ug/l	ug/l	ug/l	ug/l	ug/g	ug/g	ug/l	ug/l
Benzene	<1	14	-[c]	-	-	-	2.3[d]	-
Ethylbenzene	4.2	380	-	2.5[d]	-	0.005	-	-
Chloroform	1.1	20	<1	2.3	-	-	4.2	15
Bromodichloromethane	-	-	-	-	-	-	-	7.2
Dibromochloromethane	-	-	-	-	-	-	-	2.6
Tetrachloroethylene	<1	78	1.2	1.4	-	-	-	<1
Toluene	<1	280	2.1	9.6	0.006	0.036[e]	-	-
1,1-Dichloroethane	-	1.5	-	-	-	-	<1	1.4
1,1,1-Trichloroethane	<1	22	<1	1	-	-	-	-
Trichloroethylene	1.7	110	<1	1.7	-	-	-	<1
Methylene Chloride	10	40	-	-	-	-	8	8.1
EXTRACTABLE ORGANICS	ug/l	ug/l	ug/l	ug/l	ug/g	ug/g	ug/l	ug/l
Phenol	3.5	61	-	5.1	-	-	4.2	4.8
Naphthalene	-	58	-	5.1	-	5.8	-	2.8
Phenanthrene	-	-	-	-	-	1.9	-	-
Butyl-benzyl-phthalate	-	9	0.1	0.3	-	-	-	0.4
Di-n-octyl Phthalate	-	-	-	-	-	-	-	<1
Diethyl Phthalate	10	52	-	-	-	-	-	-
Bis(2-ethylhexyl) Pnthalate	-	53	-	-	-	-	7.2	16
1,4-Dichlorobenzene	4	7	-	-	-	1.5	-	0.8
1,2-Dichlorobenzene	-	-	-	-	-	-	-	0.4

APPENDIX 3.5

TABLE 3.5-1, Continued

SUMMARY OF DOMESTIC LAGOON SAMPLING RESULTS

Pollutant Category/ Pollutant	Lagoon Influent		Lagoon Effluent[a]		Lagoon Sludge[b]		Monitoring Wells	
	Min	Max	Min	Max	Min	Max	Min	Max
PCBS/PESTICIDES	ug/l	ug/l	ug/l	ug/l	ug/g	ug/g	ug/l	ug/l
Aroclor 1254 (PCB 1254)	-	-	-	-	-	0.5	-	-
Lindane (gamma BHC)	-	-	-	6.3	-	-	-	-
METALS	ug/l	ug/l	ug/l	ug/l	ug/g	ug/g	ug/l	ug/l
Antimony	-	-	-	-	0.8	2.8	-	-
Arsenic	-	5.1	-	11	2.1	15.4	6.3	28
Barium[f]	85	135	51	83	26.0	1,482	8.9	300
Cadmium	-	6.4	-	-	0.7	17.6	6	8
Chromium	5.6	77	-	-	7.0	54	5.8	63
Copper	27.5	173	27	67	11.0	2,100	26	200
Lead	6.9	174	5.7	13	3.0	574	0.31	740
Mercury	0.2	3	-	-	0.2	29.6	0.2	0.4
Nickel	-	-	-	-	8.7	39	53	342
Selenium	-	-	5.2	7.8	1.3	22	7.4	14
Silver	13	22	-	-	1.2	95	-	-
Thallium	3.4	3.7	3.5	3.9	-	-	2.4	5.7
Zinc	41	228	24	117	25.0	1,340	18	10,600
OTHER	ug/l	ug/l	ug/l	ug/l	ug/g	ug/g	ug/l	ug/l
Cyanide	-	-	43	63	-[g]	-	-	-
Total Phenols[f]	18.5	238	13.3	78.8	-[g]	-	10.4	45.3

APPENDIX 3.5

TABLE 3.5-1, Continued

SUMMARY OF DOMESTIC LAGOON SAMPLING RESULTS

Pollutant Category/ Pollutant	Lagoon Influent		Lagoon Effluent[a]		Lagoon Sludge[b]		Monitoring Wells	
	Min	Max	Min	Max	Min	Max	Min	Max
NON-CONVENTIONAL POLLUTANTS	mg/l	mg/l	mg/l	mg/l			mg/l	mg/l
TOC (Total organic carbon)[f]	35.6	141	8.6	58.4	-	-	1.1	78.4
Chloride[f]	14.5	776	15.7	453	-	-	2.4	382
NH_3 - N (ammonia)[f]	2.76	28.65	0.066	28.3	-	-	0.042	26.1
NO_2/NO_3 - N[f]	0.042	1.72	0.043	2.29	-	-	0.050	7.25

Notes:

[a] Includes lagoon wastewater samples.
[b] Wet weight basis.
[c] "-" indicates all measured values were below detection limits.
[d] Single value based on one data point.
[e] Also detected in two sludges at 5 and 80 ug/l.
[f] Not a priority pollutant.
[g] Sludge not analyzed for this pollutant.

APPENDIX 3.5

TABLE 3.5-2

POLLUTANT FREQUENCY OF OCCURRENCE: DOMESTIC LAGOONS

Pollutant Category/ Pollutant	Lagoon Influent		Lagoon Effluent[a]		Lagoon Sludge		Total Source[b]			Monitoring Wells	
	No. of Samples	Times Detected	No. of Samples	Times Detected	No. of Samples	Times Detected	No. of Samples	Times Detected	Percent Detected	No. of Samples	Times Detected
Volatiles	26		15		7		48			37	
Benzene		9		0		0		9	19		1
Ethylbenzene		6		1		1		8	17		0
Chloroform		24		4		0		28	58		1
Bromodichloromethane		0		0		0		0	0		1
Dibromochloromethane		0		0		0		0	0		1
Tetrachloroethylene		10		2		0		12	25		2
Toluene		20		2		3		25	52		0
1,1-Dichloroethane		1		0		0		1	2		2
1,1,1-Trichloroethane		7		1		0		8	17		0
Trichloroethylene		8		2		0		10	21		3
Methylene Chloride		2		0		0		2	4		3
Extractable Organics	7		14		8		29			37	
Phenol		3		1		0		4	14		4
Naphthalene		1		1		1		3	10		1
Phenanthrene		0		0		1		1	3		0
Butyl-benzyl-phthalate		1		1		0		2	7		1
Di-n-octyl phthalate		0		0		0		0	0		1
Diethyl Phthalate		3		0		0		3	10		0
Bis (2-ethylhexyl) Phthalate		1		0		0		1	3		3
1,4-Dichlorobenzene		2		0		1		3	10		1
1,2-Dichlorobenzene		0		0		1		1	3		0
PCBs/Pesticides	9		15		7		31			38	
Aroclor 1254 (PCB 1254)		0		0		1		1	3		0
Lindane (gamma BHC)		0		1		0		1	3		0

APPENDIX 3.5

TABLE 3.5-2, Continued

POLLUTANT FREQUENCY OF OCCURRENCE: DOMESTIC LAGOONS

Pollutant Category/ Pollutant	Lagoon Influent		Lagoon Effluent[a]		Lagoon Sludge		Total Source[b]			Monitoring Wells	
	No. of Samples	Times Detected	No. of Samples	Times Detected	No. of Samples	Times Detected	No. of Samples	Times Detected	Percent Detected	No. of Samples	Times Detected
Metals	9		15		8		32			38	
Antimony		0		0		5		5	16		0
Arsenic		1		2		7		10	31		2
Barium[c]		5		4		6		15	47		14
Beryllium		0		0		0		0	0		0
Cadmium		1		0		7		8	25		8
Chromium		2		0		8		10	31		5
Copper		9		2		8		19	59		4
Lead		8		4		8		20	63		24
Mercury		6		0		7		13	41		3
Nickel		0		0		8		8	25		1
Selenium		0		3		5		8	25		2
Silver		2		0		6		8	25		0
Thallium		2		2		0		4	13		13
Zinc		9		5		8		22	69		25
Other	9		15		0		24			38	
Cyanide		0		2				2	8		0
Total Phenols[c]		9		7				16	67		11
Non-Conventional Constituents	9		15		0		24			38	
TOC (total organic carbon)[c]		9		15				24	100		34
Chloride[c]		9		15				24	100		37
NH3-N (ammonia)[c]		8		14				22	92		28
NO_2/NO_3-N[c]		6		10				16	67		18

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[a] Includes lagoon wastewater samples.

[b] Lagoon influent, effluent and sludge are all considered potential sources of pollutants in lagoon seepage.

[c] Not a priority pollutant.

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TABLE S 1 — LARAMIE, WYOMING LAGOON SYSTEM CONTAMINANT SUMMARY   DATA COLLECTED AUGUST 1985

CONTAMINANT CATEGORY / contaminant		SAMPLE LOCATION and CONCENTRATION							
		MONITORING WELLS				WASTEWATER	TREATED WASTEWATER		LAGOON SLUDGE CONCENTRATION wet weight basis, ug/g
		Up MW1	Down gradient MW2	MW3	MW4	INFLUENT	LAGOON LIQUID	LAGOON EFFLUENT	
VOLATILES - STANDARD EQUATABLE									
benzene	ug/l				2.3	7-14			
chloroform	ug/l					9-21	1		
ethylbenzene	ug/l					4.2-360	2.5		
tetrachloroethylene	ug/l					13-63	1.2		
toluene	ug/l					9.8-280	2.1		5.1 ug/l
1,1,1- trichloroethane	ug/l					(1-15			
trichloroethylene	ug/l					3.5-11	1		
EXTRACTABLE ORGANICS									
phenol	ug/l	4.4j						5.1j	
naphthalene	ug/l						5.1j		
PCBs/ PESTICIDES									
lindane	ug/l						6.3		
METALS									
antimony	ug/l								2.2
arsenic	ug/l								5.2
barium	ug/l					91	83		656
beryllium	ug/l								
cadmium	ug/l	6.0							17.5
chromium	ug/l				12a	77			54
copper	ug/l					81			818
lead	ug/l					40	8.7		224
mercury	ug/l					.7			10
nickel	ug/l								16.4
selenium	ug/l		7.4				7.8	5.8	11
silver	ug/l								8.8
thallium	ug/l	5.5	5.0	5.7	4.6	3.7	3.9	3.5	
zinc	ug/l					180	46		882
OTHER PRIORITY POLLUTANTS									
Cyanide, ug/l							61		-
Total phenolics, ug/l						75.0	23.7		-
CONVENTIONAL CONTAMINANTS, mg/l									
Total Organic Carbon		7.6	9.4	11.7	7.1	80.4	26.4	8.6	-
CHLORIDE		46.7	96.9	159	111	60.6	91.6	87.3	-
NH3 - N (ammonia)		2.79	2.76	2.76	2.76	8.82	8.75	8.77	-
NO2/NO3 - N			.054		.081	.44	1.77	2.29	-

a — value may be high, BLANK (850809-01) concentration = 13 ug/l

j — ESTIMATED CONCENTRATION, detected @ concentration below accurate quantification.
- not analyzed
NOTES:
Trace concentrations ((1 ug/l) set equal to 1 ug/l, blank indicates value below detectable limit.

TABLE 5 2 -- LANDER , WYOMING LAGOON SYSTEM CONTAMINANT SUMMARY   DATA COLLECTED AUGUST 1985

CONTAMINANT CATEGORY / contaminant		SAMPLE LOCATION and CONCENTRATION							
		MONITORING WELLS				WASTEWATER	TREATED WASTEWATER		LAGOON SLUDGE CONCENTRATION wet weight basis, ug/g
		Up	Down gradient						
		MW1	MW2	MW3	MW4	INFLUENT	LAGOON LIQUID	LAGOON EFFLUENT	
VOLATILES - STANDARD EQUATABLE									
chloroform	ug/l					12-15	1		
tetrachloroethylene	ug/l					47-50	1.4		
toluene	ug/l								80 ug/l
trichloroethylene	ug/l	1				1.7-6			
EXTRACTABLE ORGANICS									
phenol	ug/l	4.5j	4.8j	4.2j					
naphthalene	ug/l		2.8j						
PCBs/ PESTICIDES, ug/l									
none detected									
METALS									
antimony	ug/l								2.8
arsenic	ug/l								4.7
barium	ug/l	143	172	154	8.9	85	61	51	1482
cadmium	ug/l		6.5						15.3
chromium	ug/l								48.2
copper	ug/l					27.5	27		891
lead	ug/l		11		740				574
mercury	ug/l					.3			10.4
nickel	ug/l								27.3
selenium	ug/l				14		5.2		6.4
silver	ug/l					13			4.4
thallium	ug/l	2.9	2.7	2.4	3.0	1.4			
zinc	ug/l				28	48	26		1185
OTHER PRIORITY POLLUTANTS									
CYANIDE									
Total phenolics, ug/l					15.6	26.8	48.5		-
CONVENTIONAL CONTAMINANTS, mg/l									
Total Organic Carbon			12.0			118	18.8	19.4	-
CHLORIDE		4.1	22.7	5.88	4.22	14.5	16.1	15.7	-
NH3 - N (ammonia)			1.15	.042		2.76	7.62	7.63	-
NO2/NO3 - N				.24a	.056a	.639	.201	.113	-

a — equipment blank (850609-14) contained 0.052 mg/l NO2/NO3-n

j — ESTIMATED CONCENTRATION, detected @ concentration below accruate quantification.
- not analyzed
NOTES:
Trace concentrations ((1 ug/l) set equal to 1 ug/l, blank indicates value below detectable limit.

TABLE S 3 -- BUFFALO , WYOMING LAGOON SYSTEM CONTAMINANT SUMMARY   DATA COLLECTED AUGUST 1985

CONTAMINANT CATEGORY / contaminant		SAMPLE LOCATION and CONCENTRATION						
		MONITORING WELLS				WASTEWATER	TREATED	LAGOON SLUDGE CONCENTRATION wet weight basis, ug/g
		Up	Down gradient					
		MW1	MW2	MW3	MW4	INFLUENT	LAGOON LIQUID	
VOLATILES - STANDARD EQUATABLE								
chloroform	ug/l					8.0-20	2.3	
toluene	ug/l					4.1-5.1	9.6	
1,1,1- trichloroethane	ug/l					1		
methylene chloride	ug/l		8.1		8.0			
EXTRACTABLE ORGANICS, ug/l								
PCBs/ PESTICIDES, ug/l								
none detected								
METALS								
antimony	ug/l							.8
arsenic	ug/l							
barium	ug/l	163	68		88.5	118	59	748
beryllium	ug/l							
cadmium	ug/l	6.3		7.5	5.5			6.4
chromium	ug/l							9.3
copper	ug/l					173	67	627
lead	ug/l		8.6a	6.2a		13		216
mercury	ug/l							4.3
nickel	ug/l							18.2
selenium	ug/l							
silver	ug/l							9.2
thallium	ug/l	2.4	2.4	2.9	2.8			
zinc	ug/l	271b	202b	644b	114b	150	59	596
OTHER PRIORITY POLLUTANTS								
CYANIDE								
Total phenolics, ug/l						128		-
CONVENTIONAL CONTAMINANTS, mg/l								
Total Organic Carbon		18.8	13.1	78.4	43.5	71.7	58.4	-
CHLORIDE		7.06	5.87	17.4	15.0	34.2	33.9	-
NH3 - N (ammonia)			.075	.81	.076	7.61	7.63	-
NO2/NO3 - N		.072		.078	.075			

a — equipment blank (850809-27) contained 34 ug/l lead
b — equipment blanks (850809-27,-31) contained 45 ug/l and 66 ug/l zinc respectively

- not analyzed
NOTES:
Trace concentrations ((1 ug/l) set equal to 1 ug/l, blank indicates value below detectable limit.

TABLE S 4 -- HONEY BROOK, PA LAGOON SYSTEM CONTAMINANT SUMMARY SAMPLES COLLECTED JULY 1985

CONTAMINANT CATEGORY / contaminant		SAMPLE LOCATION and CONCENTRATION				
		MONITORING WELLS		WASTEWATER INFLUENT	TREATED LAGOON LIQUID	LAGOON SLUDGE CONCENTRATION wet weight basis, ug/g
		Up gradient	Down gradient			
VOLATILES - STANDARD EQUATABLE						
chloroform	ug/l			2.2-4.7		
toluene	ug/l			1		
EXTRACTABLE ORGANICS, ug/l						
phenol				61j,a		
naphthalene				58j,a		5.8j
phenanthrene						1.9j
1,2- dichlorobenzene						0.4j
1,4- dichlorobenzene						1.5j
diethyl-phthalate				52j,a		
PCBs/ PESTICIDES, ug/l						
Arochlor 1254						.5
METALS						
antimony	ug/l					1.8
arsenic	ug/l					15.4
barium	ug/l	87	61	71		345
cadmium	ug/l					16
chromium	ug/l					48
copper	ug/l			143		944
lead	ug/l			18		166
mercury	ug/l	.3	.2	.4		9.2
nickel	ug/l					39
selenium	ug/l					1.3
silver	ug/l					1.2
zinc	ug/l	18	63	123	24	1096
OTHER PRIORITY POLLUTANTS						
Cyanide, ug/l					43	-
Total phenolics, ug/l				61.9	13.1	-
CONVENTIONAL CONTAMINANTS, mg/l						
Total Organic Carbon		1.1		87.6	29.4	-
CHLORIDE		14.7	7.16	51	53.7	-
NH3 - N (ammonia)				4.17	5.23	-
NO2/NO3 - N		6.3b	2.58	.042	1.07	-

a -- actual detection limit = 100 ug/l for this sample
b -- value may be high, up gradient MW equipment blank (850725-09) contained 2.1 mg/l NO2/NO3-N

Field blank (850725-01) contained 6.9j ug/l bis(2-ethylhexy)-phthalate and 4.4j ug/l di-n-butyl-phthalate
j -- ESTIMATED CONCENTRATION, detected @ concentration below accurate quantification.
- not analyzed

NOTES:
Trace concentrations (< 1 ug/l) set equal to 1 ug/l, blank indicates values below detectable limit.

TABLE S 6 -- MINOT, ND LAGOON SYSTEM CONTAMINANT SUMMARY DATA COLLECTED SEPTEMBER 1985

CONTAMINANT CATEGORY / contaminant		SAMPLE LOCATION and CONCENTRATION							
		MONITORING WELLS				WASTEWATER	TREATED WASTEWATER		LAGOON SLUDGE CONCENTRATION wet weight basis, ug/g
		Up MW1	Down gradient MW2	MW3	MW4	INFLUENT	LAGOON LIQUID	LAGOON EFFLUENT	
VOLATILES - STANDARD EQUATABLE									
1,1- dichloroethane	ug/l					1.5			
chloroform	ug/l			13		9.4-10			
bromodichloromethane	ug/l			7.2					
dibromochloromethane	ug/l			2.6					
tetrachloroethylene	ug/l					2-5			
toluene	ug/l					2.6-4.7			
1,1,1- trichloroethane	ug/l					7-22			
trichloroethylene	ug/l				1	12-110	1		
methylene chloride	ug/l					10-40			
EXTRACTABLE ORGANICS, ug/l									
butyl-benzyl-phthalate		0.4j				9j,b		0.1j	
di-n-octyl phthalate		0.9j							
diethyl phthalate						10j,b			
bis(2-ethylhexy) phthalate		16	7.2		9.7	53j,b			
1,4- dichlorobenzene						7j,b			
PCBs/ PESTICIDES, ug/l									
none detected									
METALS									
antimony	ug/l								
arsenic	ug/l	6.3				5.1		11	4.6
barium	ug/l								
beryllium	ug/l								
cadmium	ug/l					6.4			5.4
chromium	ug/l	16	31	11	5.8	24			33
copper	ug/l	36		44		97			233
lead	ug/l	15	10	28		174		7.4	215
mercury	ug/l			.2		.6			4.8
nickel	ug/l			53					18
selenium	ug/l								4.2
silver	ug/l					22			25
thallium	ug/l								
zinc	ug/l	151	54	151	58	228			507
OTHER PRIORITY POLLUTANTS									
CYANIDE									
Total phenolics, ug/l		12.8	45.3		10.4	84.0	36.8	17.8	-
CONVENTIONAL CONTAMINANTS, mg/l									
Total Organic Carbon		6.6	7.2	13.4	9.0	35.6	29.3	20.6	-
CHLORIDE		10.5	115	153	135	188	126	166	-
NH3 - N (ammonia)		.104	.057	.043	.376		14.46	.066	
NO2/NO3 - N		.321		.065		.042	.043		-

a — analyzed as liquid
b — actual detection limit = 10 x MDL for this sample

j — ESTIMATED CONCENTRATION, detected @ concentration below accurate quantification
- not analyzed
NOTES:
Trace concentrations ((1 ug/l) set equal to 1 ug/l, blank indicates value below detectable limit.

TABLE S 7 -- McVILLE, ND LAGOON SYSTEM CONTAMINANT SUMMARY DATA COLLECTED SEPTEMBER 1985

CONTAMINANT CATEGORY / contaminant		SAMPLE LOCATION and CONCENTRATION						
		MONITORING WELLS				WASTEWATER	TREATED	LAGOON SLUDGE CONCENTRATION wet weight basis, ug/g
		Up MW1	Down gradient MW2	MW3	MW4	INFLUENT	LAGOON LIQUID	
VOLATILES - STANDARD EQUATABLE								
1,1- dichloroethane	ug/l		1.4	1				
chloroform	ug/l					1.1-2.7		
ethylbenzene	ug/l							.005
toluene	ug/l					9.6-11		.006
trichloroethylene	ug/l			1				
EXTRACTABLE ORGANICS, ug/l								
phenol						10j,a		
diethyl phthalate						11j,a		
1,4- dichlorobenzene			0.8j			4j,a		
PCBs/ PESTICIDES, ug/l								
none detected								
METALS								
antimony	ug/l							1.8
arsenic	ug/l		17	28				5.5
barium	ug/l							
beryllium	ug/l							
cadmium	ug/l			6.6				5.7
chromium	ug/l							36
copper	ug/l			90	26	164		2100
lead	ug/l	16	16	88	14	18	12	223
mercury	ug/l					3.0		29.6
nickel	ug/l							23
selenium	ug/l							22
silver	ug/l							95
thallium	ug/l							
zinc	ug/l	30		47	27	131		1340
OTHER PRIORITY POLLUTANTS								
CYANIDE								
Total phenolics, ug/l		10.4	16.6		10.4	137	16.6	-
CONVENTIONAL CONTAMINANTS, mg/l								
Total Organic Carbon		5.5	13.8	8.7	4.8	110	32.4	-
CHLORIDE		3.11	229	212	220	776	258	-
NH3 - N (ammonia)			18.28		26.1b	25.4	11.07	-
NO2/NO3 - N		7.25	.089	.081	.145			

a -- actual detection limit = 10xMDL
b — equipment blank (850927-32) contained 26.8 mg/l NH3-N

j -- ESTIMATED CONCENTRATION, detected @ concentration below accurate quantification
- not analyzed
NOTES:
Trace concentrations ((1 ug/l) set equal to 1 ug/l, blank indicates value below detectable limit.

TABLE S 8 — BRITTON VILLAGE, MI LAGOON SYSTEM CONTAMINANT SUMMARY DATA COLLECTED NOVEMBER 1985

CONTAMINANT CATEGORY / contaminant		SAMPLE LOCATION and CONCENTRATION							
		MONITORING WELLS				WASTEWATER	TREATED WASTEWATER		LAGOON SLUDGE CONCENTRATION wet weight basis, ug/g
		Up MW1	Down gradient MW2	MW3	MW4	INFLUENT	LAGOON LIQUID	LAGOON EFFLUENT	
VOLATILES - STANDARD EQUATABLE									
chloroform	ug/l					4			
toluene (see note a),	ug/l								
EXTRACTABLE ORGANICS, ug/l									
phenol						3.5j,b			
bis(2-ethylhexyl) phthalate (see note c)									
PCBs/ PESTICIDES, ug/l									
none detected									
METALS									
antimony	ug/l								
arsenic	ug/l							11	6.8
barium	ug/l					135			118
beryllium	ug/l								
cadmium	ug/l								.7
chromium	ug/l								14.5
copper	ug/l					89			38.7
lead	ug/l	5.5	8.7	11.5	6.5	11	13		9.5
mercury	ug/l					.2			.2
nickel	ug/l								26
selenium	ug/l								
silver	ug/l								
thallium	ug/l								
zinc	ug/l	746e	1040e	2230e	701e	115	117		97
OTHER PRIORITY POLLUTANTS									
CYANIDE									
Total phenolics, ug/l						82.2			-
CONVENTIONAL CONTAMINANTS, mg/l									
Total Organic Carbon		12.8	7.8	16.2	6.6	102	31.4	25.9	-
CHLORIDE		15.9	15.3	9.3	23.0	160	146	140	-
NH3 - N (ammonia)		.071		.077		20.4	1.25		-
NO2/NO3 - N							1.23		

a — blanks (851120-20/21) contaminated w/)60 ug/l toluene, no valid results for this contaminant
b — actual detection limit = 10x NDL for this sample

c — blanks (851120-20/21) contaminated w/ 31,3.0j ug/l, respectively of this contaminant
e — value may be high , blank (851120-20) contained 4120 ug/l zinc
j — ESTIMATED CONCENTRATION, detected @ concentration below accurate quantification
- not analyzed
NOTES:
Trace concentrations ((1 ug/l) set equal to 1 ug/l, blank indicates value below detectable limit.

TABLE 5 5 — POTTERVILLE, MI LAGOON SYSTEM CONTAMINANT SUMMARY DATA COLLECTED NOVEMBER 1985

CONTAMINANT CATEGORY / contaminant		SAMPLE LOCATION and CONCENTRATION							
		MONITORING WELLS				WASTEWATER	TREATED WASTEWATER		LAGOON SLUDGE CONCENTRATION wet weight basis, ug/g
		Up MW1	Down gradient MW2	MW3	MW4	INFLUENT	LAGOON LIQUID	LAGOON EFFLUENT	
VOLATILES - STANDARD EQUATABLE, ug/l (holding time) 7 days)									
chloroform						2-3			
ethylbenzene						8-12			
benzene						4-6			
toluene						21-33			
tetrachloroethylene			1						
EXTRACTABLE ORGANICS, ug/l									
bis(2-ethylhexyl) phthalate (see note a)									
PCBs/ PESTICIDES, ug/l									
none detected									
METALS									
antimony	ug/l								
arsenic	ug/l								2.1
barium	ug/l		190	300	120				26
beryilium	ug/l								
cadmium	ug/l								
chromium	ug/l								7.0
copper	ug/l					44			11
lead	ug/l	149	22	27	34	6.9			3.0
mercury	ug/l								
nickel	ug/l								8.7
selenium	ug/l								
silver	ug/l								
thallium	ug/l								
zinc	ug/l	4460	10600	3370	5340	73			25
OTHER PRIORITY POLLUTANTS									
CYANIDE									
Total phenolics, ug/l			12.9	17.0	14.8	33.5	13.3		-
CONVENTIONAL CONTAMINANTS, mg/l									
Total Organic Carbon		3.8	5.1	4.2	6.4	59.5	26.2	20.2	-
CHLORIDE		3.0	382	254		155	380	453	-
NH3 - N (ammonia)			.125	.053	.105	13.55	1.77	5.95	-
NO2/NO3 - N		5.38		.156		1.72	.239		-

a — blanks (851121-28) contaminated w/ 3.2j ug/l of this contaminant

- not analyzed

NOTES:
Trace concentrations ((1 ug/l) set equal to 1 ug/l, blank indicates value below detectable limit.

TABLE S 10 — STANDISH, MI LAGOON SYSTEM CONTAMINANT SUMMARY DATA COLLECTED NOVEMBER 1985

CONTAMINANT CATEGORY / contaminant		SAMPLE LOCATION and CONCENTRATION						
		MONITORING WELLS				WASTEWATER	TREATED WASTEWATER	
		Up	Down gradient					
		MW1	MW2	MW3 .	MW4	INFLUENT	LAGOON LIQUID	LAGOON EFFLUENT
VOLATILES - STANDARD EQUATABLE, ug/l (holding time) 7 days)								
chloroform						8	1	
1,1,1- trichloroethane							1	
benzene						1		
toluene						2-3		
tetrachloroethylene						1		
EXTRACTABLE ORGANICS, ug/l								
PCBs/ PESTICIDES, ug/l								
none detected								
METALS								
antimony	ug/l							
arsenic	ug/l							
barium	ug/l							
beryllium	ug/l							
cadmium	ug/l							
chromium	ug/l							
copper	ug/l					28		
lead	ug/l		0.31a		7.2a	9.3a		
mercury	ug/l							
nickel	ug/l							
selenium	ug/l							
silver	ug/l							
thallium	ug/l							
zinc	ug/l					41		
OTHER PRIORITY POLLUTANTS								
CYANIDE								
Total phenolics, ug/l						18.5		
CONVENTIONAL CONTAMINANTS, mg/l								
Total Organic Carbon		4.2	1.8	8.0	6.6	40.9	19.8	22.7
CHLORIDE		2.4	3.1	3.3	2.6	68.4	92.8	111
NH3 - N (ammonia)		.203	.27	.358	.26	3.76	5.48	1.84
NO2/NO3 - N						.709	.207	.674

a — blank (851125-45) contaminated w/ 19 ug/l of lead, duplicate (851125-43) contained 31 ug/l lead

- not analyzed

NOTES:
Trace concentrations (< 1 ug/l) set equal to 1 ug/l, blank indicates value below detectable limit.

APPENDIX 3.5

TABLE 3.5-3

SUMMARY OF DOMESTIC/INDUSTRIAL LAGOON SAMPLING RESULTS

Pollutant Category/ Pollutant	Lagoon Influent		Lagoon Effluent[a]		Lagoon Sludge[b]	
	Min	Max	Min	Max	Min	Max
VOLATILES	ug/l	ug/l	ug/l	ug/l	ug/kg	ug/kg
Acrolein	13.4	63.8	2.3	3.5	58.2	58.2
Acrylonitrile	1.7	83.8	2.1	4.4	86	86.7
Benzene	1	153	0.99	11	99	99
Ethylbenzene	0.6	17.8	0.4	0.99	4	130
Carbon Tetrachloride	0.13	0.13	-[c]	-	-	-
Chloroform	0.21	747	0.06	86	2.61	2.61
Chlorobenzene	0.66	61.8	0.99	0.99	20.7	3,700
Chloroethane	0.26	80.3	12.1	12.1	0.58	3.59
Bromodichloromethane	1	2	-	-	-	-
Tetrachloroethylene	0.71	361	3	31	-	-
Toluene	1	1,964	1	34	2.5	3,300
Trans-1,2-dichloroethylene	6	6	0.99	0.99	80	80
1,1-Dichloroethane	0.14	3	0.99	0.99	-	-
1,1-Dichloroethylene	0.99	0.99	-	-	-	-
1,2-Dichloroethane	730	730	1.17	164	0.06	0.06
1,2-Dichloropropane	3.84	3.84	5.46	5.46	0.22	0.22
1,1,1-Trichloroethane	1.06	93	0.99	9	0.25	40
1,1,2-Trichloroethane	0.09	99.2	4.15	4.15	19.8	19.8
1,1,2,2-Tetrachloroethane	6.4	17	-	-	-	-
Trichloroethylene	0.73	56.7	0.4	2	-	-
Methyl Chloride	0.99	0.99	5	5	-	-
Methylene Chloride	5.2	340	0.49	280	0.34	0.34
Vinyl Chloride	0.62	11.6	1.9	1.9	50	50
EXTRACTABLE ORGANICS	ug/l	ug/l	ug/l	ug/l	ug/kg	ug/kg
Acid						
Phenol	1.72	233	0.71	44	10	26,500
2-Chlorophenol	2	742	0.99	90	26.6	3,560
2,4-Dichlorophenol	2	164	0.41	10.6	123	32,500
2,4-Dimethylphenol	0.6	273	0.98	35.3	128	20,000
4-Chloro-3-Methylphenol	0.85	113	0.36	40.4	26.4	124,000
2-Methyl-4,6-Dinitrophenol	5.2	578	-	-	775	34,200
2-Nitrophenol	3.81	491	0.85	96.9	19	61,500
4-Nitrophenol	4.91	527	6.96	824	193	23,000
2,4-Dinitrophenol	7.42	553	320	320	243	45,300
Pentachlorophenol	0.99	828	5.44	416	61	126,000
2,4,6-Trichlorophenol	0.71	289	0.64	47.8	117	132,000

APPENDIX 3.5

TABLE 3.5-3, Continued

SUMMARY OF DOMESTIC/INDUSTRIAL LAGOON SAMPLING RESULTS

Pollutant Category/ Pollutant	Lagoon Influent		Lagoon Effluent[a]		Lagoon Sludge[b]	
	Min	Max	Min	Max	Min	Max
EXTRACTABLE ORGANICS, continued						
Base/Neutral	ug/l	ug/l	ug/l	ug/l	ug/kg	ug/kg
Acenaphthene	0.99	110	7.1	7.72	22.5	1,530
Acenaphthylene	0.99	4.24	2.68	2.68	6,300	6,300
Anthracene	0.91	12	1.49	1.49	11.5	6,100
Benzidine	1.11	0.15	0.12	0.84	1.14	2.25
Benzo (a) Anthracene	0.12	0.99	-	-	0.35	1,590
Benzo (a) Pyrene	0.05	0.99	0.09	0.09	0.13	0.13
Benzo (b) Fluoranthene	0.44	0.44	0.28	0.28	42.4	344
Benzo (ghi) Perylene	0.2	12.5	-	-	-	-
Benzo (k) Fluoranthene	0.32	0.59	1.24	1.24	21.2	1,110
Dibenzo (a,h) Anthracene	0.1	1.9	0.58	1	103	1,410
2-Chloronaphthalene	0.1	165	8.4	173	1.81	10,900
Chrysene	0.99	30.3	0.99	4.2	2.81	15,000
n-Nitrosodimethylamine	0.24	9.34	2.66	2.66	36.6	713
n-Nitrosodiphenylamine	0.28	1.45	0.14	123	14.3	282
n-Nitrosodi-n-propylamine	-	-	0.16	3.6	0.83	2,120
3,3'-Dichlorobenzidine	0.69	23	0.99	6	4,000	44,000
Dimethyl Phthalate	0.94	118	3.25	78.7	430	240,000
Fluoranthene	0.8	18	0.32	0.99	38.1	1,260
Fluorene	0.99	37.4	0.92	1.1	40	389
Indeno (1,2,3-cd) Pyrene	0.05	19.1	0.19	0.19	20.6	529
Pyrene	0.54	3.2	0.95	1.61	29	8,320
1,2,4-Trichlorobenzene	0.99	0.99	-	-	-	-
Naphthalene	4	130	0.99	0.99	50	580
Phenanthrene	0.91	2.6	0.99	0.99	29.1	1,560
Di-n-butyl Phthalate	0.11	4.68	0.99	5.17	4.42	964
Butyl-benzyl-phthalate	0.75	1	0.2	22.93	0	280
Di-n-octyl Phthalate	0.14	5.75	0.6	0.6	0.54	171
Diethyl Phthalate	0.99	0.99	-	-	-	-
Bis(2-ethylhexyl) Phthalate	0.23	0.23	0.63	80	10.7	11,700
1,2-Dichlorobenzene	1.4	31.9	0.7	6.2	101	7,560
1,4-Dichlorobenzene	1	23.2	1.05	8.7	200	4,030
1,3-Dichlorobenzene	1.8	22.9	0.6	27.6	153	4,880
2,4-Dinitrotoluene	0.63	36.9	4.1	42.6	0.43	194,000
2,6-Dinitrotoluene	0.15	109	0.27	32.8	0.22	35,600
Isophorone	1.06	30.1	-	-	251	5,100

APPENDIX 3.5

TABLE 3.5-3, Continued

SUMMARY OF DOMESTIC/INDUSTRIAL LAGOON SAMPLING RESULTS

Pollutant Category/ Pollutant	Lagoon Influent		Lagoon Effluent[a]		Lagoon Sludge[b]	
	Min	Max	Min	Max	Min	Max
Base/Neutral, continued	ug/l	ug/l	ug/l	ug/l	ug/kg	ug/kg
Nitrobenzene	5.47	48.9	-	-	189	189
Bis (2-chloroethyl) Ether	2.1	202	1.3	3.9	90.5	4,420
Bis (2-chloroethoxy) Methane	3.6	448	4.7	15.7	115	8,560
Bis (2-chloroisopropyl) Ether	0.4	1,430	2.5	60	1.06	9,140
4-Bromophenyl Phenyl Ether	6.5	89.1	0.25	9	9.17	13,200
4-Chlorophenyl Phenyl Ether	0.99	288	1.4	32.9	73	42,500
Hexachlorobenzene	0.13	326	0.15	32	17.7	58,000
Hexachlorobutadiene	0.3	5.43	0.2	0.2	1.83	274
Hexachloroethane	0.19	11.5	0.2	235	15.8	36,100
PCBs/PESTICIDES	ug/l	ug/l	ug/l	ug/l	ug/kg	ug/kg
Lindane (gamma BHC)	0.1	0.1	0.1	0.1	-	-
Dieldrin	-	-	0.031	0.031	-	-
OTHER	ug/l	ug/l	ug/l	ug/l	ug/kg	ug/kg
Cyanide	4	23	0.1	3.5	95.1	9,000
Total Phenolics[d]	5.7	260	1.4	204	142	20,700
METALS	ug/l	ug/l	ug/l	ug/l	ug/g	ug/g
Antimony	5.3	7	2.3	105	0.09	2.2
Arsenic	2.4	77.7	0.5	88.4	0.55	24
Barium[d]	22.8	58.2	12.55	47.1	0.66	240
Beryllium	1.4	15.2	0.7	7.4	0.17	20
Cadmium	1	2.7	0.3	7.4	0.009	37
Chromium	4.6	78	2.2	35.2	4.79	208
Copper	28.8	330	5.6	55	4.87	1,034
Lead	1.7	200	1	16.7	7.6	999
Mercury	0.3	0.7	0.4	0.4	0.01	11.4
Nickel	6.9	45	3.8	5,103.6	3.5	221
Selenium	27.7	118	27.7	208	0.36	9.6
Silver	1.1	10.9	1	4	0.04	81
Thallium	14	17.7	17.7	17.7	0.04	0.18
Zinc	155	4,670	22	535.5	0.36	1,176

APPENDIX 3.5

TABLE 3.5-3, Continued

SUMMARY OF DOMESTIC/INDUSTRIAL LAGOON SAMPLING RESULTS

Pollutant Category/ Pollutant	Lagoon Influent		Lagoon Effluent[a]		Lagoon Sludge[b]	
	Min	Max	Min	Max	Min	Max
NON-CONVENTIONAL POLLUTANTS	mg/l	mg/l	mg/l	mg/l	ug/g	ug/g
Total Organic Carbon[d]	66.1	248	16.4	144	34,000	90,000
Chloride[d]	21.1	1,200	17.6	630	1.53	720
NH_3 - N (ammonia)[d]	6.7	28.05	0.44	73.2	110	3,480
NO_2/NO_3 - N[d]	0.105	11.5	0.1	7.32	-	-
Total Solids, percent[d]	-	-	-	-	4.8	37

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[a] Includes lagoon wastewater samples.
[b] Dry weight basis.
[c] "-" indicates all values below detection limits.
[d] Not a priority pollutant.

APPENDIX 3.5

TABLE 3.5-4

POLLUTANT FREQUENCY OF OCCURRENCE: DOMESTIC/INDUSTRIAL LAGOONS

Pollutant Category/ Pollutant	Lagoon Influent		Lagoon Effluent[a]		Lagoon Sludge		Total Source[b]		
	No. of Samples	Times Detected	No. of Samples	Times Detected	No. of Samples	Times Detected	No. of Samples	Times Detected	Percent Detected
VOLATILES	15		17		16		48		
Acrolein		4		2		1		7	15
Acrylonitrile		4		2		2		8	17
Benzene		6		6		1		13	27
Ethylbenzene		6		2		5		13	27
Carbon Tetrachloride		1		0		0		1	2
Chloroform		9		6		1		16	33
Chlorobenzene		8		1		3		12	25
Chloroethane		5		1		2		8	17
Bromodichloromethane		2		0		0		2	4
Tetrachloroethylene		9		3		0		12	25
Toluene		5		2		8		15	31
Trans-1,2-dichlorothylene		1		1		1		3	6
1,1-Dichloroethane		2		1		0		3	6
1,1-Dichloroethylene		1		0		0		1	2
1,2-Dichloroethane		1		3		1		5	10
1,2-Dichloropropane		1		1		1		3	6
1,1,1-Trichloroethane		2		3		2		7	15
1,1,2-Trichloroethane		4		1		1		6	13
1,1,2,2-Tetrachloroethane		2		0		0		2	4
Trichloroethylene		5		4		0		9	19
Methyl Chloride		1		1		0		2	4
Methylene Chloride		5		4		1		10	21
Vinyl Chloride		4		1		1		6	13
EXTRACTABLE ORGANICS	15		17		16		48		
Acid									
Phenol		13		10		9		32	67
2-Chlorophenol		7		4		4		15	31
2,4-Dichlorophenol		10		7		5		22	46
2,4-Dimethylphenol		11		6		4		21	44
4-Chloro-3-Methylphenol		10		4		8		22	46
2-Methyl-4,6-Dinitrophenol		5		0		6		11	23
2-Nitrophenol		8		6		4		18	38
4-Nitrophenol		9		6		5		20	42
2,4-Dinitrophenol		4		1		3		8	17
Pentachlorophenol		10		5		7		22	46
2,4,6-Trichlorophenol		10		8		8		26	54

APPENDIX 3.5

TABLE 3.5-4

POLLUTANT FREQUENCY OF OCCURRENCE: DOMESTIC/INDUSTRIAL LAGOONS

Pollutant Category/ Pollutant	Lagoon Influent		Lagoon Effluent[a]		Lagoon Sludge		Total Source[b]		
	No. of Samples	Times Detected	No. of Samples	Times Detected	No. of Samples	Times Detected	No. of Samples	Times Detected	Percent Detected
EXTRACTABLE ORGANICS, continued									
Base Neutral	15		17		16		48		
Acenaphthene		4		3		4		11	23
Acenaphthylene		2		1		1		4	8
Anthracene		5		1		4		10	21
Benzidine		2		3		2		7	15
Benzo (a) Anthracene		3		0		4		7	15
Benzo (a) Pyrene		2		1		1		4	8
Benzo (b) Fluoranthene		1		1		2		4	8
Benzo (ghi) Perylene		2		0		0		2	4
Benzo (k) Fluoranthene		2		1		3		6	13
Dibenzo (a,h) Anthracene		2		2		3		7	15
2-Chloronaphthalene		6		5		7		18	38
Chrysene		7		1		8		18	38
n-Nitrosodimethylamine		3		1		3		7	15
n-Nitrosodiphenylamine		4		5		6		15	31
n-Nitrosodi-n-propylamine		0		2		3		5	10
3,3'-Dichlorobenzidine		2		2		3		7	15
Dimethyl Phthalate		10		8		9		27	56
Fluoranthene		4		3		5		12	25
Fluorene		5		2		4		11	23
Indeno (1,2,3-cd) Pyrene		2		1		2		5	10
Pyrene		7		3		5		15	31
1,2,4-Trichlorobenzene		1		0		0		1	2
Naphthalene		3		1		4		8	17
Phenanthrene		3		1		6		10	21
Di-n-butyl phthalate		10		8		11		29	60
Butyl-benzyl-phthalate		2		6		6		14	29
Di-n-octyl Phthalate		2		1		5		8	17
Diethyl Phthalate		2		0		0		2	4
Bis (2-ethylhexyl) Phthalate		7		8		10		25	52
1,2-Dichlorobenzene		8		7		9		24	50
1,4-Dichlorobenzene		7		4		9		20	42
1,3-Dichlorobenzene		7		5		8		20	42
2,4-Dinitrotoluene		4		4		7		15	31
2,6-Dinitrotoluene		5		5		6		16	33
Isophorone		5		0		2		7	15

APPENDIX 3.5

TABLE 3.5-4

POLLUTANT FREQUENCY OF OCCURRENCE: DOMESTIC/INDUSTRIAL LAGOONS

Pollutant Category/ Pollutant	Lagoon Influent		Lagoon Effluent[a]		Lagoon Sludge		Total Source[b]		
	No. of Samples	Times Detected	No. of Samples	Times Detected	No. of Samples	Times Detected	No. of Samples	Times Detected	Percent Detected
Base Neutral, continued	15		17		16		48		
Nitrobenzene		5		0		1		6	13
Bis (2-chloroethyl) Ether		9		4		5		18	38
Bis (2-chloroethoxy) Ether		5		3		4		12	25
Bis (2-chloroisopropyl) Ether		9		6		7		22	46
4-Bromophenyl Phenyl Ether		7		3		4		14	29
4-Chlorophenyl Phenyl Ether		9		5		8		22	46
Hexachlorobenzene		7		6		8		21	44
Hexachlorobutadiene		5		2		7		14	29
Hexachloroethane		7		4		7		18	38
PCBs/PESTICIDES	15		16		12		43		
Lindane (gamma BHC)		1		1		0		2	5
Dieldrin		0		1		0		1	2
OTHER	12		15		15		42		
Cyanide		3		2		6		11	26
Total Phenolics[c]		10		11		6		27	64
METALS	15		17		14		46		
Antimony		2		3		7		12	26
Arsenic		9		9		8		26	57
Barium[c]		11		11		11		33	72
Beryllium		10		10		10		30	65
Cadmium		10		9		13		32	70
Chromium		13		12		14		39	85
Copper		14		13		14		41	89
Lead		13		14		14		41	89
Mercury		5		1		11		17	37
Nickel		12		13		13		38	83
Selenium		8		6		9		23	50
Silver		11		9		13		33	72
Thallium		2		1		4		7	15
Zinc		15		14		14		43	93

APPENDIX 3.5

TABLE 3.5-4

POLLUTANT FREQUENCY OF OCCURRENCE: DOMESTIC/INDUSTRIAL LAGOONS

Pollutant Category/ Pollutant	Lagoon Influent		Lagoon Effluent[a]		Lagoon Sludge		Total Source[b]		
	No. of Samples	Times Detected	No. of Samples	Times Detected	No. of Samples	Times Detected	No. of Samples	Times Detected	Percent Detected
NON-CONVENTIONAL POLLUTANTS	13		15		12		40		
Total Organic Carbon[c]	10	10	11	11	9	9	30	30	100
Chloride[c]		13		15		10		38	95
NH_3 - N (ammonia)[c]		13		9		11		33	83
NO_3^-/NO_2^- - N[c]		7		4		0		11	28
Total Solids, percent[c]						14	14	14	100

[a] Includes lagoon wastewater samples.
[b] Lagoon influent, effluent and sludge are all considered potential sources of pollutants in lagoon seepage.
[c] Not a priority pollutant.

TABLE A Raw Wastewater Influent Characterization of MUNICIPAL/INDUSTRIAL LAGOONS

CONTAMINANT CATEGORY / contaminant	MUSKEGON, MI (a)	EVERETT, WA # 1 (b)	EVERETT, WA #2	MANDAN, ND	HEBRON, IL	DEXTER, MO	ATKINS, AR	HATTIESBURG, MS COMBINED (c)	HATTIESBURG, MS DOMESTIC (c)	ALEX-ANDRIA, LA	SCOTTS BLUFF, NE	MINONG, WI	GLENDIVE, MT (c)	RIDGECREST, CA INF	RIDGECREST, CA PRIMARY	ANDREWS, SC	PICKENS, SC	RANGE MINIMUM	RANGE MAXIMUM	DETECTION SUMMARY	
CURRENT FLOW, mgd	33	12.5		11.5 ~~3.51~~	.26	.30	.25	9.0		9.5	3.9	.09	.93	4.25		.91	.26	.09	33	NUMBER OF SAMPLES	NUMBER O DETECTION
PERCENT INDUSTRIAL	70	5		3	77	78	88	40		5	15	11	2	55		29	75	2	88		
METALS, ug/l	NA (d)																			16	
antimony					5.3		7											5.3	7		
arsenic		14	3.5		8.3			2.4		77.7	16.7	4.8	13.1	23.9	28.7			2.4	77.7		1
barium *					44	58.2	22.8	48.7	48.7	48.7	45.5	26.7	36.1	33	28.3		28	22.8	58.2		1
beryllium					7.8	4.2	3.4	15.2	4.4	3	2	1.8	1.4	2.2	1.8			1.4	15.2		1
cadmium		2	2.2		1		1.1	2.7		2	1.7	1	1.1	2.4	2.4			1	2.7		1
chromium		30	8	5.6	78	4.6	51.3	28.2	8.4	27.8	7.7	8.9	19.8	13.9	18.8			4.6	78		1
copper		180	31.2	42	34.4	39.6	34.2	46.2	28.8	90.7	75.8	42.6	50	34.4	50	330	78	28.8	330		1
lead		10	12	20	8.5	4.9	5.1	4.1	4.6	12.3	6.7	1.7	5.4	4.2	6.7	200		1.7	200		1
mercury			.3	.7	.3			.7					.55					.3	.7		
nickel		15	24.3		15.6	12.4	30	6.9	8.1	8.8	21.6	24.2	16.7	45	16.7			6.9	45		1
selenium					59		118	27.7	27.7	34.7	28		54.1	27.8	23.2			23.2	118		
silver		5	4.8		1.2		10.1	8.8	6.5	10.9	1.3	1.9	3.3	1.1	2.2			1.1	10.9		1
thallium					14									17.7	14.7			14	17.7		
zinc		339	218.3	155	4670	266	3936	438	183	371	269	376	1150	271	290	1700	190	155	4670		1
NON-CONVENTIONAL CONTAMINANTS, ug/l	NA	NA	NA																	14	
Total Organic Carbon *				141	248	127	110	134		66.1	177	124	170	76.1	44	NA	NA	44	248		1
CHLORIDE *				73.2	627	95	83.3	44.3	21.1	40	160	23.4	31.5	81	48.1	1200	33	21.1	1200		1
NH3 - N (ammonia) *				28.05	7.9	11.4	8.8	7.32	11.7	11.7	13.2	17.6	10.3	23.4	27.8	6.7	8.1	6.7	28.05		1
NO2/NO3 - N *				.105	2.4	.28		11.5		7.24	.742						1.6	.105	11.5		
PCBs/ PESTICIDES, ug/l	NA		NA																	16	
lindane (gamma BHC)		.1																.1	.1		
dieldrin																					
OTHER PRIORITY POLLUTANTS, ug/l	NA		NA													NA	NA			13	
cyanide							23	4		4								4	23		
total phenolics		5.7		238			80	10	78	260	156	18	109	28	38			5.7	260		1
VOLATILES, ug/l			NA																	16	
acrolein						19.3	31.1	63.8	13.4									13.4	63.8		
acrylonitrile						18.7	31	83.8	1.7									1.7	83.8		
benzene	153						50.6	6	4.9	4.4			1					1	153		
ethylbenzene	14						17.8	1.1	.6	16.6						5.2		.6	17.8		
carbon tetrachloride													.13					.13	.13		
chloroform	747			14				3.67	.21	.6		12.3	6.77			3	8.3	.21	747		
chlorobenzene	23					10.7	11.7	11.2	2.12	61.8	.66		.92					.66	61.8		
chloroethane	.99						80.3	.44	.26				7.47					.26	80.3		
bromodichloromethane	2																1	1	2		
tetrachloroethylene	361			72	1		11.7			5.31	1.82		63.5	.71	56.6	1		.71	361		1
toluene	1964			2.7				2.3		1.1							1	1	1964		
trans-1,2- dichloroethene	6																	6	6		
1,1- dichloroethane	3							.14										.14	3		
1,1- dichloroethylene	.99																	.99	.99		
1,2- dichloroethane	730																	730	730		
1,2- dichloropropane							3.84											3.84	3.84		
1,1,1- trichloroethane	93												1.06					1.06	93		
1,1,2- trichloroethane								5.09		.09		99.2		60.8	99.2			.09	99.2		
1,1,2,2- tetrachloroethane		6.4											17					6.4	17		
trichloroethylene	36							2.01			.73	56.7				4		.73	56.7		
methyl chloride	.99																	.99	.99		
methylene chloride	43						340	11.6	5.2			84.5						5.2	340		
vinyl chloride	1							.82		.62		11.6						.62	11.6		

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TABLE A   Raw Wastewater Influent Characterization of   MUNICIPAL/INDUSTRIAL LAGOONS (continued)

CONTAMINANT CATEGORY / contaminant	MUSKEGON, MI (a)	EVERETT, WA		MANDAN, ND	HEBRON, IL	DEXTER, MO	ATKINS, AR	HATTIESBURG, MS		ALEX-ANDRIA, LA	SCOTTS BLUFF, NE	WIXOM, MI	GLENDIVE, MT (c)	RIDGECREST, CA		ANDREWS, SC	PICKENS, SC	RANGE		DETECTION SUMMARY	
		#1 (b)	#2					COMBINED (c)	DOMESTIC (c)					INF	PRIMARY			MINIMUM	MAXIMUM		
CURRENT FLOW, mgd	33	12.5		1.5 ~~2.0~~	.26	.30	.25	9.0		9.5	3.9	.09	.93	4.25		.91	.26	.09	33	NUMBER OF SAMPLES	NUMBER O DETECTION
PERCENT INDUSTRIAL	70	5		3	77	78	88	40		5	15	11	2	55		29	75	2	88		
EXTRACTABLE ORGANICS, ug/l			NA																	16	
ACID																					
phenol	5	13.2		26	5.29	14	233	26.8	1.72	25.8	13.6	7.21	112	14.2	1.29			1.29	233		1
2-chlorophenol	2					119	742	4.12		8.24	130			2.61	.69			.69	742		
2,4- dichlorophenol	2				6.2	23	85.5	3.33	22	6.61	13.5	3.57	164					2	164		1
2,4- dimethylphenol	1				7.5	14	176	52.1	.6	9.47	40.9	3.15	273	1.01				.6	273		1
4-chloro-3-methylphenol					8.4	84.4	5.13	1.86	.85	14.8	1.39	74.4	113			7.2		.85	113		1
2-methyl-4,6-dinitrophenol						578	404	5.2		61			106					5.2	578		
2-nitrophenol					11.4	151	262	126		13.3	75.7		491	3.81	.45			.45	491		
4-nitrophenol					343	527		289	371	198	16.1	12.7	463	4.91	11			4.91	527		1
2,4-dinitrophenol					53	553		28.7		7.42								7.42	553		
pentachlorophenol	.99				207	828	37.7	43.8		221	16.4	60.8	52.6	19.2				.99	828		1
2,4,6- trichlorophenol	2				8.2	46	34.8	10.6	1	6.07		62.3	289	.71				.71	289		1
BASE/NEUTRAL																					
acenaphthene	.99					44.5		9.44		110								.99	110		
acenaphthylene	.99									4.24								.99	4.24		
anthracene	.99					5.4		2.24	.91	12								.91	12		
benzidine						.15							.11					.11	.15		
benzo (a) anthracene	.99					.12				.71								.12	.99		
benzo (a) pyrene	.99				.05													.05	.99		
benzo (b) fluoranthene						.44												.44	.44		
benzo (ghi) perylene					.2	12.5												.2	12.5		
benzo (k) fluoranthene								.32	.59									.32	.59		
dibenzo (a,h) anthracene								.1		1.9								.1	1.9		
2-chloronaphthalene	.99				3.5	57.8		165	14.6				.1					.1	165		
chrysene	.99				4.8	22.6	1.39	30.3	8.57	9.45								.99	30.3		
n-nitrosodimethylamine								.24		9.34			1.04					.24	9.34		
n-nitrosodiphenylamine						1.45		.62		.49	.28							.28	1.45		
n-nitrosodi-n-propylamine																					
3,3'- dichlorobenzidine	23							.69										.69	23		
dimethyl phthalate	4				6.5	.94	69.5		3.13	38	118	48.7	1.53	90.9	9.71			.94	118		1
fluoranthene	18				.8	.8				8.68								.8	18		
fluorene	.99					2	7.2		3.44	37.4								.99	37.4		
indeno (1,2,,3-cd) pyrene					.05	19.1												.05	19.1		
pyrene	.99				1.4	3.2	2.39	2.66	.54	3.1								.54	3.2		
1,2,4-trichlorobenzene	.99																	.99	.99		
naphthalene	4									54.1						130		4	130		
phenanthrene	1					2.6			.91									.91	2.6		
di-n-butyl phthalate	.99	.99			3.3	.45		.11		4.68	.27	1.35	1.56	4.29	8.68			.11	8.68		1
butyl-benzyl-phthalate	1					.75												.75	1		
di-n-octyl phthalate								.14		5.75								.14	5.75		
diethyl phthalate	.99	.99																.99	.99		
bis(2-ethylhexyl) phthalate	23	9.1				.69	2.9	3.56			.23			9.13	2.11			.23	23		
1,2- dichlorobenzene	4				1.4	2.3		9.6	4.1	3.6		28.5		31.9				1.4	31.9		
1,4- dichlorobenzene	1				3.3		2.1	2.5		14.2		9.65		23.2				1	23.2		
1,3- dichlorobenzene					2.8	1.8	7.1	10.3	6.5			22.9		18.6				1.8	22.9		
2,4-dinitrotoluene					10.3	9.8				36.9			.63					.63	36.9		
2,6-dinitrotoluene					11.2	1.795	13.8			109			.15					.15	109		
isophorone						5.91	7.1	30.1	17.9	1.06								1.06	30.1		
nitrobenzene						27.07		48.9	10.1	11.7		5.47						5.47	48.9		
bis (2-chloroethyl) ether					30	202	17	2.1	3.21	64.7		13.3	55.5	36.2				2.1	202		
bis (2-chloroethoxy) methane					3.6	448		34.9	67.7	4.3								3.6	448		
bis (2-chloroisopropyl) ether					.5	1,430	38.8	.4	.4	48.3		2.33	44.2	16.8				.4	1430		
4-bromophenyl phenyl ether					6.5	7.2	7.1	89.1		28.3			12.1	14.2	.91			.91	89.1		
4-chlorophenyl phenyl ether	.99				30.2	288	11.4	8.9	25.8	34.3		3.92	33.3					.99	288		
hexachlorobenzene						243	51.2	326	13.6	49.1			.83	.13				.13	326		
hexachlorobutadiene							1.9	.3	.4			.83		5.43				.3	5.43		
hexachloroethane					.3	1.6		1.9	.2	11.5		.19		1.18				.19	11.5		

* -- non-priority pollutant
0.99 = trace (< 1 ug/l)
All samples 24 hour composites except as noted below
a -- Average 1980/81 data
b -- #1, Dec. 19, 1984 24 hr composite
#2 Average of 6 - 24 hr composites, metals only
c -- grab samples due to sampler malfunction
d -- NA -- Sample not analyzed for this contaminant category

TABLE 8 Wastewater Effluent Characterization of MUNICIPAL/INDUSTRIAL LAGOONS

CONTAMINANT CATEGORY / contaminant	MUSKEGON, MI (a)		EVERETT, WA #1 (b)	EVERETT, WA #2	MANDAN, ND LIQ (c)	MANDAN, ND EFF (c)	HEBRON, IL	DEXTER, MO	ATKINS, AR	HATTIESBURG: POND 2	HATTIESBURG: POND 4 (c)	ALEX-ANDRIA, LA	SCOTTS BLUFF, NE	MINONG, WI	GLEN-DIVE, MT (c)	RIDGECREST, CA: EFF	RIDGECREST, CA: POND 10 (c)	ANDREWS, SC	PICKENS, SC	RANGE MINIMUM	RANGE MAXIMUM	DETECTION SUMMARY NUMBER OF SAMPLES	DETECTION SUMMARY NUMBER OF DETECTIONS
CURRENT FLOW, mgd	33		12.5		~~2.5~~ 1.5		.26	.30	.25	9.0		9.5	3.9	.09	.93	4.25		.91	.26	.09	33		
PERCENT INDUSTRIAL	70		5		3		77	78	88	40		5	15	11	2	55		29	75	2	88		
METALS, mg/l	NA (d)																					17	
antimony							2.3		10.6								105			2.3	105		3
arsenic			5	1						.5	3.6		10.8	4.8	14.3	15.5	88.4			.5	88.4		9
barium *							36.1	31.4	34.2	45.7	36.1	28.2	47.1	12.55	30.6	23.8	28.3			12.55	47.1		11
beryllium							5.4	5.7	5.2	7.4	3.7	5.8	2	.7		3.2	3.6			.7	7.4		10
cadmium			1.2	.3			1.2	7.4	1.3		1.3		1	.3			5.1			.3	7.4		9
chromium			13	2.2			7.7	7	35.2	4.4	9.2	12.5	5.5	4		4	10.9			2.2	35.2		12
copper			9	5.6			6.2	13.2	18	14.2	31.3	30.7	24.7	14.75		26.2	27.9	55		5.6	55		13
lead			1	2.2	5.7	8.5	2.4	3.5	6.4	2.3	5.6	3.6	3.3	3.35		4.7	16.7			1	16.7		14
mercury				(.1							.4									.4	.4		1
nickel			24	8.7			8.8	30.1	18.8	3.8	6.2	9.2	25	5101.6	10.8	16.7	16.7			3.8	5101.6		13
selenium							48.6		208		27.7		54		71.2		171			27.7	208		6
silver			1.3	1.5			4	1.8	1		3.5	2		1.6			1.9			1	4		9
thallium																	17.7			17.7	17.7		1
zinc			174		31		100	49	283	134	180	56	254	535.5		183	196	200	22	22	535.5		14
NON-CONVENTIONAL CONTAMINANTS, mg/l	NA		NA	NA																		15	
Total Organic Carbon *					29.4	16.4	144	70.6	105		25.3	50	98.7	64	122		87.5	NA	NA	16.4	144		11
CHLORIDE *					76.4	71.3	473	73.5	150	17.6	26.2	31.1	150	29.2	57.1	141	376	630	45	17.6	630		15
NH3 - N (ammonia) *					7.16	28.3		.44		29.05	73.2				2.93	16.1		3.5	11	.44	73.2		9
NO2/NO3 - N *					.1	1.47						7.24		7.32						.1	7.32		4
PCBs/ PESTICIDES, mg/l	NA			NA																		16	
lindane (gamma BHC)			.1																	.1	.1		1
dieldrin																			.031	.031	.031		1
OTHER PRIORITY POLLUTANTS, mg/l				NA														NA	NA			15	
cyanide						.1			3.5											.1	3.5		2
total phenolics			1.4		19	18.2	41		23			189	204	16.5	106	5	28			1.4	204		11
VOLATILES - STANDARD EQUATABLE, mg/l				NA																		17	
acrolein								2.3			3.5									2.3	3.5		2
acrylonitrile								2.1			4.4									2.1	4.4		2
benzene	11	.99					2.1		9.4	6.7	8.1									.99	11		6
ethylbenzene	.99											.4								.4	.99		2
carbon tetrachloride																							0
chloroform	86	9			.99	1.2						.06			2.01					.06	86		6
chlorobenzene	.99																			.99	.99		1
chloroethane															12.1					12.1	12.1		1
bromodichloromethane																							0
tetrachloroethylene	31	3											3.32							3	31		3
toluene	34	1																		1	34		2
trans-1,2- dichloroethene	.99																			.99	.99		1
1,1- dichloroethane	.99																			.99	.99		1
1,1- dichloroethylene																							0
1,2- dichloroethane	164	14											1.17							1.17	164		3
1,2- dichloropropane													5.46							5.46	5.46		1
1,1,1- trichloroethane	9	.99			1															.99	9		3
1,1,2- trichloroethane								4.15												4.15	4.15		1
1,1,2,2- tetrachloroethane																							0
trichloroethylene	2	.99			1.7									.4						.4	2		4
methyl chloride															5					5	5		1
methylene chloride	31	.99							280		.49									.49	280		4
vinyl chloride														1.9						1.9	1.9		1

TABLE 9 Wastewater Effluent Characterization of MUNICIPAL/INDUSTRIAL LAGOONS (continued)

CONTAMINANT CATEGORY / contaminant	MUSKEGON, MI (a)		EVERETT, WA #1 (b)	#2	MANDAN, ND LID (c)	EFF (c)	HEBRON, IL	DEXTER, MO	ATKINS, AR	HATTIESBURG: POND 2	POND 4 (c)	ALEX-ANDRIA, LA	SCOTTS BLUFF, NE	MINONG, WI	GLEN-DIVE, MT (c)	RIDGECREST, CA: EFF	POND 10 (c)	ANDREWS, SC	PICKENS, SC	RANGE MINIMUM	MAXIMUM	DETECTION SUMMARY NUMBER OF SAMPLES	NUMBER OF DETECTIONS
CURRENT FLOW, mgd	33		12.5		~~[illegible]~~ .5		.26	.30	.25	9.0		9.5	3.9	.09	.93	4.25		.91	.26	.09	33		
PERCENT INDUSTRIAL	70		5		3		77	78	88	40		5	15	11	2	55		29	75	2	88		
EXTRACTABLE ORGANICS, ug/l				NA																		17	
ACID																							
phenol	5	2	.99					.71			.73	2.37	6.92	44	4.24	2.42				.71	44		10
2-chlorophenol	.99	.99														6.04	90			.99	90		4
2,4- dichlorophenol	.99							10.6			7.04		.41	6.3		10.2	5.02			.41	10.6		7
2,4- dimethylphenol								4.76	3.61		9.56			5.51	.98		35.3			.98	35.3		6
4-chloro-3-methylphenol								40.4			1.56	.36				.53				.36	40.4		4
2-methyl-4,6-dinitrophenol																							0
2-nitrophenol								1.35			.85	1.37		20.3		11.6	96.9			.85	96.9		6
4-nitrophenol								824			25.5	102			22.8	11.9	6.96			6.96	824		6
2,4-dinitrophenol								320												320	320		1
pentachlorophenol								416						5.44	15.1	29.8	28.5			5.44	416		5
2,4,6- trichlorophenol	1	.99						23.4	47.8		20.3	21.1			2.24	.64				.64	47.8		8
BASE/NEUTRAL																							
acenaphthene									7.71	7.1		7.72								7.1	7.72		3
acenaphthylene									2.68											2.68	2.68		1
anthracene												1.49								1.49	1.49		1
benzidine								.84			.12				.15					.12	.84		3
benzo (a) anthracene																							0
benzo (a) pyrene												.09								.09	.09		1
benzo (b) fluoranthene										.28										.28	.28		1
benzo (ghi) perylene																							0
benzo (k) fluroanthene										1.24										1.24	1.24		1
benzo (a,h) anthracene										1		.58								.58	1		2
2-chloronaphthalene								173	31	8.4	30.8	13.3								8.4	173		5
chrysene	.99								2.1	4.2										.99	4.2		3
n-nitrosodimethylamine										2.66										2.66	2.66		1
n-nitrosodiphenylamine								.14	.75	.51	123	72.3								.14	123		5
n-nitrosodi-n-propylamine									3.6			.16								.16	3.6		2
3,3'- dichlorobenzidine	6	.99																		.99	6		2
dimethyl phthalate								3.25	8.28	78.7		3.74	9.49	7.3		4.27	11			3.25	78.7		8
fluoranthene	.99						.48					.32								.32	.99		3
fluorene										1.1		.92								.92	1.1		2
indeno (1,2,3-cd) pyrene												.19								.19	.19		1
pyrene		.99							1.61	.95										.95	1.61		3
1,2,4-trichlorobenzene																							0
naphthalene	.99																			.99	.99		1
phenanthrene	.99																			.99	.99		1
di-n-butyl phthalate	.99						1.84		1.3	2.4			1.11		2.37	5.17	1.54			.99	5.17		8
butyl-benzyl-phthalate					.2	.3			.59			1.76		22.93			1.87			.2	22.93		6
di-n-octyl phthalate						.6														.6	.6		1
diethyl phthalate																							0
bis(2-ethylhexyl) phthalate	9	3	10.7		6.9				2.48				.63	5.59				80		.63	80		8
1,2- dichlorobenzene	.99							6.2	5.8	5	5.3	.7					1.02			.7	6.2		7
1,4- dichlorobenzene									4.6	8.7		1.3					1.05			1.05	8.7		4
1,3-dichlorobenzene									9	27.6	10.2	.6					.76			.6	27.6		5
2,4-dinitrotoluene								12.3	4.1	5.165		42.6								4.1	42.6		4
2,6-dinitrotoluene									32.8	2.655	10	32.1				.27				.27	32.8		5
isophorone																							0
nitrobenzene																							0
bis (2-chloroethyl) ether										2.6	3.9			1.3			1.64			1.3	3.9		4
bis (2-chloroethoxy) methane								4.7		9.6	15.7									4.7	15.7		3
bis (2-chloroisopropyl) ether								60		9.75	3.1	13.2		2.5			3.64			2.5	60		6
4-bromophenyl phenyl ether										9						.25	.33			.25	9		3
4-chlorophenyl phenyl ether								29.3	1.4	9.4	32.9			1.85						1.4	32.9		5
hexachlorobenzene								6.7	32	4.1	9.2	3			.15					.15	32		6
hexachlorobutadiene									.2		.2									.2	.2		2
hexachloroethane								1.3	2.7	235		.2								.2	235		4

* -- non-priority pollutant
0.99 = trace (< 1 ug/l)
All samples 24 hr composites except as noted below
a -- Average 1980/81 data
b -- #1, Dec. 19,1984 24 hr. composite
#2 - Average of 6 - 24 hr composites,metals only
c -- grab sample
d -- NA -- Sample not analyzed for this contaminant category

TABLE C Sludge Characterization of MUNICIPAL/INDUSTRIAL LAGOONS

CONTAMINANT CATEGORY / contaminant	MUSKEGON, MI CELL II (a)	EAST (b)	WEST	EVERETT, WA (c)	MANDAN, ND (d)	HEBRON, IL	DEXTER, MO	ATKINS, AR	HATTIES-BURG, MS	ALEX-ANDRIA, LA	SCOTTS-BLUFF, NE	MINONG, WI	GLENDIVE, MT	RIDGE-CREST, CA	ANDREWS, SC	PICKENS, SC AERATED	POLISHING	RANGE MINIMUM	MAXIMUM	DETECTION SUMMARY	
CURRENT FLOW, mgd	33			12.5	1.5	.26	.30	.25	9.0	9.5	3.9	.09	.93	4.25	.91	.26		.09	33	NUMBER OF SAMPLES	NUMBER OF DETECTIONS
PERCENT INDUSTRIAL	70			5	3	77	78	88	40	5	15	11	2	55	29	75		2	88		
METALS, ug/g	NA (e)	NA	NA																	14	
antimony					1.4	.201		.195			.0964	.0939	.263	2.2				.0939	2.2		7
arsenic				24	6.0	1.23				1.26	.547	.895	1.68	2.18				.547	24		8
barium						8.73	6.35	19.6	8.48		38.1	.65	67	.656	48	240	160	.656	240		11
beryllium						.367	.169	.433	.514	.483	.2	.179	.728	.678	20			.169	20		10
cadmium				37	8.1	2.52	1.7	1.19	2.2	3.86	.0096	2.5	2.45	1.27		5.4	6	.0096	37		13
chromium				208	38	33.6	172.5	13.9	160.8	112	11.6	4.79	13.9	6	30	57	91	4.79	208		14
copper				1034	502	30.4	20.6	4.87	35.6	267	56.1	19.2	43.3	38.9	88	290	240	4.87	1034		14
lead				999	324	15.4	8.49	7.6	42.6	69.1	16.6	7.92	36.8	14.9	120	98	240	7.6	999		14
mercury				9	11.4	.0411	.0358	.0107	.11	.353	.0158	.0968	.0979	.0169				.0107	11.4		11
nickel				87	25	6.36	221	5.82	129.6	21.3	3.5		10.9	4.17	16	26	39	3.5	221		13
selenium				2	9.6	.551		2.97	1.94	2.77	.357		2.7	.633				.357	9.6		9
silver				81	52	.376	.172	.0676	.316	5.17	.0443	.177	.184	.1		6.2	3.6	.0443	81		13
thallium											.0395	.183	.155	.16				.0395	.183		4
zinc				1776	1164	77.3	1.26	6.01	116.8	.357	182	79.4	143.6	69.2	720	730	1200	.357	1776		14
NON-CONVENTIONAL CONTAMINANTS, ug/g	NA	NA	NA	NA	NA															12	
Total Organic Carbon *						68000	90000	81400	58300	60600	67800	34000	44600	47500	NA	NA	NA	34000	90000		9
CHLORIDE *						74.2	53.8	340.8	120	54.3	1.53	2.46	2.23	3.11	720	NA	380	1.53	720		11
NH3 - N (ammonia) *						3480	2250	1060	110	753	655	3040	1026	1600	500	1300	2300	110	3480		12
NO2/NO3 - N *																					0
Total solids, percent *				11.8	9.2	7.6	5.2	8.4	5.0	7.0	22.3	4.8	5.7	5.5	37	12	5	4.8	37		14
PCBs/ PESTICIDES, ug/kg	NA	NA	NA	(d)	NA															12	
lindane (gamma BHC)																					0
dieldrin																					0
OTHER PRIORITY POLLUTANTS, ug/kg																NA	NA			15	
cyanide				9000			113	95.1	160	214	134							95.1	9000		6
total phenolics				NA			171	142			789	1710	20700	2640				142	20700		6
VOLATILES, ug/kg				NA																16	
acrolein								58.2										58.2	58.2		1
acrylonitrile								86.7	86									86	86.7		2
benzene															99			99	99		1
ethylbenzene		4						40.3		17.1					89		130	4	130		5
carbon tetrachloride																					0
chloroform													2.61					2.61	2.61		1
chlorobenzene										20.7			28.1		3700			20.7	3700		3
chloroethane											.58		1.59					.58	1.59		2
bromodichloromethane																					0
tetrachloroethylene																					0
toluene	730	3			36			136		61.2			2.5		73	50	3300	2.5	3300		9
trans-1,2- dichloroethene															80			80	80		1
1,1- dichloroethane																					0
1,1- dichloroethylene																					0
1,2- dichloroethane											.06							.06	.06		1
1,2- dichloropropane											.22							.22	.22		1
1,1,1- trichloroethane													.25		40			.25	40		2
1,1,2- trichloroethane							19.8											19.8	19.8		1
1,1,2,2- tetrachloroethane																					0
trichloroethylene																					0
methyl chloride																					0
methylene chloride												.34						.34	.34		1
vinyl chloride															50			50	50		1

TABLE C Sludge Characterization of MUNICIPAL/INDUSTRIAL LAGOONS (continued)

CONTAMINANT CATEGORY / contaminant	MUSKEGON, MI CELL II (a)	MUSKEGON, MI EAST (b)	MUSKEGON, MI WEST	EVERETT, WA (c)	MANDAN, ND (d)	HEBRON, IL	DEXTER, MO	AIKINS, AR	HATTIES-BURG, MS	ALEX-ANDRIA, LA	SCOTTS BLUFF, NE	HINDING, WI	GLENDIVE, MT	RIDGE-CREST, CA	ANDREWS, SC	PICKENS, SC AERATED POLISHING	RANGE MINIMUM	RANGE MAXIMUM	DETECTION SUMMARY NUMBER OF SAMPLES	DETECTION SUMMARY NUMBER OF DETECTION
CURRENT FLOW, mgd	33			12.5	1.5	.26	.30	.25	9.0	9.5	3.9	.09	.93	4.25	.91	.26	.09	33		
PERCENT INDUSTRIAL	70			5	3	77	78	88	40	5	15	11	2	55	29	75	2	88		
EXTRACTABLE ORGANICS, ug/kg				NA															16	
ACID																				
phenol	240					26500	9460		10	574	34.6	191	2840	167			10	26500		9
2-chlorophenol						1500			26.6	45			3560				26.6	3560		4
2,4- dichlorophenol						2730	32500			144	123		5580				123	32500		5
2,4- dimethylphenol						5640	20000				128		7430				128	20000		4
4-chloro-3-methylphenol						14100	124000		26.4	231	39.1	1590	5460	1390			26.4	124000		8
2-methyl-4,6-dinitrophenol						34200	2460			775		3000	5460	2600			775	34200		6
2-nitrophenol						61500			19	251			9500				19	61500		4
4-nitrophenol							23000				300	3850	193	3360			193	23000		5
2,4-dinitrophenol						45300	4170			243							243	45300		3
pentachlorophenol						126000	2480			188	61	2300	5210	2040			61	126000		7
2,4,6- trichlorophenol						13600	132000		117	404	201	4500	10300	3950			117	132000		8
BASE/NEUTRAL																				
acenaphthene						636		1530	22.5	194							22.5	1530		4
acenaphthylene							6300										6300	6300		1
anthracene						25.4	6100		11.5	472							11.5	6100		4
benzidine						2.25				1.14							1.14	2.25		2
benzo (a) anthracene	60						1590			567			.35				.35	1590		4
benzo (a) pyrene											.13						.13	.13		1
benzo (b) fluoranthene						42.4	344										42.4	344		2
benzo (ghi) perylene																				0
benzo (k) fluoranthene						21.2	1110		83.2								21.2	1110		3
dibenzo (a,h) anthracene						1410	1280			103							103	1410		3
2-chloronaphthalene						10900	419	2510	1720	221			1.81	993			1.81	10900		7
chrysene		310				46.6	369	15000	119	195		7.92	2.81				2.81	15000		8
n-nitrosodimethylamine						36.6				713				360			36.6	713		3
n-nitrosodiphenylamine						282	78.4	93.4		14.3	137	96.1					14.3	282		6
n-nitrosodi-n-propylamine								2120		.83			1350				.83	2120		3
3,3'- dichlorobenzidine	44000	4000	11200														4000	44000		3
dimethyl phthalate						159000	240000	20300	3300	430	29900	3250	5870	3926			430	240000		9
fluoranthene	230	220	1260			38.1				584							38.1	1260		5
fluorene	140					102		389		40							40	389		4
indeno (1,2,,3-cd) pyrene							529			20.6							20.6	529		2
pyrene	200						8320	931	29	120							29	8320		5
1,2,4-trichlorobenzene																				0
naphthalene	580	60	50							70.8							50	580		4
phenanthrene	810		200			25.1	1560	67.5		148							25.1	1560		6
di-n-butyl phthalate	310	600				4.42	542	95.1	4.44	564	810	39.7	964	169			4.42	964		11
butyl-benzyl-phthalate	280					0		1.08		25.1	.82			1.76			0	280		6
di-n-octyl phthalate						6.67			54	171	.54		61.9				.54	171		5
diethyl phthalate																				0
bis(2-ethylhexyl) phthalate	4200	4400	11700			59.4		12.1	10.7		16.8	24.1	144	67.6			10.7	11700		10
1,2- dichlorobenzene	320					426	1060	7560	702	122	101	242		930			101	7560		9
1,4- dichlorobenzene	200					1320	511	4030	404	219	203	941		323			200	4030		9
1,3- dichlorobenzene						953	1320	4880	526	207	153	839		1190			153	4880		8
2,4-dinitrotoluene							194000	175000	63600	630		.43	92.1	.52			.43	194000		7
2,6-dinitrotoluene							35600	28300	4780	479		1.16		.22			.22	35600		6
isophorone							5100			251							251	5100		2
nitrobenzene												189					189	189		1
bis (2-chloroethyl) ether						2130	4420			871			799	90.5			90.5	4420		5
bis (2-chloroethoxy) methane							8560			124		115	496				115	8560		4
bis (2-chloroisopropyl) ether							3830	1060	9140	196	1.06	278		12.3			1.06	9140		7
4-bromophenyl phenyl ether						13200	10200						235	9.17			9.17	13200		4
4-chlorophenyl phenyl ether						4040	42500	888	4360	73	255	117	487				73	42500		8
hexachlorobenzene						58000	1050	8000	11200	669	20.1	17.7	66.8				17.7	58000		8
hexachlorobutadiene							173	274	90	87	1.83	72.5		21.2			1.83	274		7
hexachloroethane							663	36100	510	66	15.8	26.5		2320			15.8	36100		7

* -- non-priority pollutant

All samples are grab samples, values based on dry weight of sludge

a -- Average 1980/81 data

b -- Concentration in east and west storage lagoon sludge, 1980.

c -- Average of 6 - grab samples, metals,cyanide,pcb's. Total PCB's = 4.7 mg/g

d -- wet weight basis

e -- NA --Sample not analyzed for this contaminant category

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APPENDIX 3.6

APPENDIX 3 REFERENCES

6

APPENDIX 3.6

APPENDIX 3 REFERENCES

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APPENDIX 4.1

ASSESSMENT METHODOLOGY

APPENDIX 4.1

ASSESSMENT METHODOLOGY

4.1.1 SELECTION OF POLLUTANTS OF CONCERN AND EXPOSURE POINT THRESHOLD CONCENTRATIONS

The first step in the assessment process was the selection of pollutants of concern and determination of their human health-based thresholds (MCLs and RSD/RfD-based concentrations, as described in Chapter 2 of the text). To this end, sampling data from the domestic and domestic/industrial lagoons were examined separately to identify any significant differences in the types and concentrations of pollutants detected. Lagoon wastewater and effluent data were expected to most closely approximate concentrations found in the lagoon (see Chapter 3 in the text), and therefore were used in this analysis.

Those pollutants most likely to be of concern in ground water were identified by comparing maximum lagoon effluent concentrations to human health-based threshold concentrations based on RSD and RfD values. (Because MCLs reflect economic and technological feasibility, they were not used for this initial screening process.) Although use of median effluent concentrations would have been more realistic than maximums, that approach was not possible because few pollutants had median concentrations above their health threshold concentrations, (in some cases, median concentrations did not even exceed analytical detection limits). Additionally, as data are available for only 23 of 5,476 lagoons, a median value would not be statistically significant.

The actual selection process was based primarily on the magnitude of the ratio of effluent concentration to the human health-based threshold for a given pollutant. Whenever this ratio was less than one (i.e., when the maximum effluent concentration was less than the corresponding threshold concentration), that pollutant was considered unlikely to cause a risk to human health via drinking water and was eliminated from further consideration.

4.1.1.1 Domestic Lagoons

Only three of the pollutants found in the effluent of domestic lagoons exceeded their respective health thresholds (see Table 4.1-1). Therefore, all three were identified as pollutants of concern for this study. It should be noted that, although the maximum effluent concentration for arsenic is only 11 ug/l, the health threshold is so low that it is exceeded by a factor of 4,721.

4.1.1.2 Domestic/Industrial Lagoons

In contrast to domestic lagoons, 21 compounds found in the effluent of domestic/industrial lagoons exceeded their respective health thresholds (see Table 4.1-2). Because the number of computer runs conducted had to be kept to a manageable number, this list of 21 chemicals was condensed. The criteria used in this selection process were:

TABLE 4.1-1

POLLUTANTS OF CONCERN (DOMESTIC LAGOONS)

Pollutant	Maximum Effluent Concentration (ug/l)[a]	Health Threshold[b] (ug/l)	Ratio[c]	Mobility[d]	Frequency of Detection[e]
Arsenic	11	0.00233[e]	4,721	High	2/15
Chloroform	2.3	0.430[e]	5.35	High	4/15
Tetrachloroethylene	1.4	0.676[e]	2.07	High	2/15

[a] From Appendix 3.5 (Table 3.5-1).

[b] Based on RSD/RfD Values.

[c] Maximum Effluent Concentration: Health Threshold.

[d] Organic carbon partition coefficient (K_{oc}) less than 2,000 l/kg (Source: Reference 1).

[e] From Appendix 3.5 (Table 3.5-2). Includes lagoon wastewater and effluent

[f] Risk specific dose (carcinogen).

TABLE 4.1-2

POLLUTANTS OF CONCERN (DOMESTIC/INDUSTRIAL LAGOONS)

Pollutant	Maximum Effluent Concentration[a] (ug/l)	Health Threshold[b] (ug/l)	Ratio[c]	Mobility[d]	Frequency of Detection[e]
Arsenic	88.4	0.00233[e]	37,939	High	9/17
Benzidine	0.84	0.00015[e]	5,600	Low	3/17
n-Nitrosodimethylamine	2.66	0.00135[e]	1,970	Low	9/17
Hexachlorobenzene	32	0.021[e]	1,524	Low	6/17
2,4-Dinitrotoluene	42.6	0.113[e]	377	High	4/17
3,3'-Dichlorobenzidine	6	0.021[e]	286	Low	2/17
Chloroform	86	0.430[e]	200	High	6/17
Vinyl chloride	1.9	0.015[e]	127	High	1/17
Bis (2-chloroethyl)ether	3.9	0.031[e]	126	Low	4/17
Methylene chloride	280	2.50[e]	112	High	4/17
Acrylonitrile	4.4	0.067[e]	65.7	High	2/17
Tetrachloroethylene	31	0.676[e]	45.9	High	3/17
Benzo(a)pyrene	0.09	0.003[e]	30.0	Low	1/17
2,4,6-Trichlorophenol	47.8	1.75[e]	27.3	Low	8/17
Bis(2-ethylhexyl)phthalate	80	3.85[e]	20.8	Low	8/17
Benzene	11	0.663[e]	16.6	High	6/17
1,1,2-Trichloroethane	4.15	0.614[e]	6.76	High	1/17
2,4-Dinitrophenol	320	70[f]	4.57	Low	1/17
Nitrate	7,320	3450[f]	2.12	High	4/17
Selenium	208	105.4[f]	1.97	NA[g]	6/17
Thallium	17.7	14.0[f]	1.26	High	1/17

---

[a] Based on RSD/RfD Values.

[b] From Appendix 3.5 (Table 3.5-3).

[c] Maximum Effluent Concentration: Health Threshold.

[d] K_{oc} less than 2000 l/kg (Source: Reference 1).

[d] From Appendix 3.5 (Table 3.5-4). Includes lagoon wastewater and effluent

[e] Risk specific dose (carcinogen).

[f] Reference dose (non-carcinogen).

[g] Not available.

- Degree of threshold exceedence (high ratio);
- Frequency of detection;
- Degree of mobility (not significant for steady-state models, but useful if transient analyses are conducted); and
- Persistence in the environment.

The four pollutants selected on the basis of these criteria are shown in Table 4.1-3, along with the three domestic lagoon pollutants (Table 4.1-1) and nitrates (included to illustrate the effects of anaerobic biodegradation).

4.1.2 EPACMS COMPUTER MODEL

The procedure used in this study for assessing the extent of potential ground-water contamination necessarily involves definition of a human health-based risk threshold concentration for each pollutant at the exposure point, back-calculation along the migration pathway to determine the corresponding source concentration which yields the threshold concentration at the exposure point, and comparison of the calculated source concentration with the known or likely source concentration. EPACMS is a two-dimensional composite numerical/analytical solution model designed to evaluate the migration of dissolved pollutants from a surface impoundment to points of interest in an underlying water-table aquifer (Figure 4.1-1). The cross-sectional model considers spatial variability of the flow field induced by mounding beneath the surface impoundment and important attenuation mechanisms such as dispersion, adsorption, first-order decay (including anaerobic, but not aerobic, biodegradation) and dilution due to recharge in the fully saturated zone. The model can also assess adsorption and first-order decay in the unsaturated zone, if desired. This option was not selected for the national assessment, as the major decay process in the unsaturated zone would be that of biodegradation, for which rate constants were not generally available (see Section 4.1.3.4).

4.1.2.1 Code Features and Applicability

EPACMS, a composite model, comprises four major components including:

- A one-dimensional finite-element code designed to simulate steady-state moisture movement through the unsaturated zone;
- A one-dimensional analytical solution for advective transport of dissolved contaminants through the unsaturated zone;
- A one-dimensional cross-sectional analytical solution for steady-state saturated ground-water flow in an anisotropic homogeneous aquifer subject to leakage from above; and
- A one-dimensional cross-sectional analytical solution for advective-dispersive transport in an aquifer subject to a variable flow field.

The four modules are designed to be utilized together to simulate the movement of pollutants from a surface impoundment (i.e., lagoon) through the unsaturated zone to the water table and finally through the saturated zone. The modules can also be used in pairs to evaluate either vertical ground-water

TABLE 4.1-3

POLLUTANTS SELECTED FOR COMPUTER MODELLING

Pollutant	Rationale
Arsenic	o Highest ratio of lagoon effluent concentration to human health-based threshold concentration for both domestic and domestic/industrial lagoons o Found in domestic lagoon monitoring wells with maximum ratio of 12,017 (ground-water concentration: threshold) o Detected in 64% of domestic/industrial lagoons sampled o Persistent o Highly mobile
Benzene	o Retained for possible comparison with earlier, site-specific modelling (SWIFT Model)
Chloroform	o Organic with highest ratio for domestic lagoons (seventh for domestic/industrial lagoons) o Detected in almost one-third of domestic lagoons sampled o Relatively persistent o Highly mobile
2,4-Dinitrotoluene	o High ratio for domestic/industrial lagoons o Persistent o Highly mobile
Hexachlorobenzene	o High ratio for domestic/industrial lagoons o Detected in over one-third of domestic/industrial lagoons sampled o Persistent o Highly immobile
Nitrate	o Anaerobic biodegradation coefficients are available for use in computer model
Tetrachloroethylene	o Ratio exceeds 1.0 for domestic lagoons o Moderately mobile

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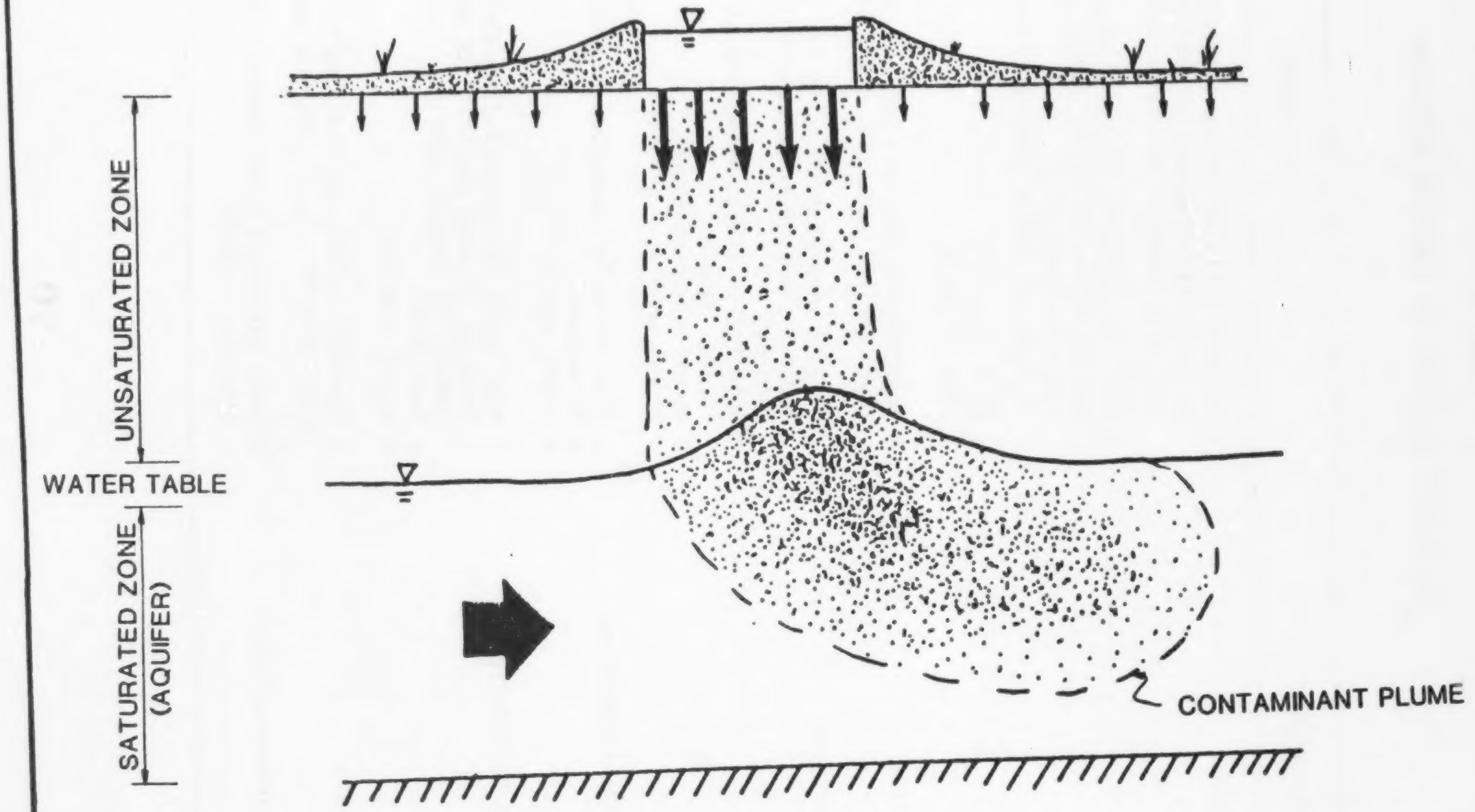
FIGURE 4.1-1

SCHEMATIC DESCRIPTION OF LAGOON
AND HYDROGEOLOGIC REGIME


UNSATURATED ZONE
WATER TABLE
SATURATED ZONE
(AQUIFER)
CONTAMINANT PLUME

flow and contaminant transport in the unsaturated zone or cross-sectional ground-water flow and contaminant transport in the saturated zone, or they can be used as individual components.

4.1.2.2 Model Description

The surface impoundment model is comprised of four modules including:

- A one-dimensional unsaturated flow finite-element module;
- An analytical model for advective transport of dissolved contaminants migrating from the surface impoundment to the saturated zone;
- An analytical solution for ground-water flow in the saturated zone; and
- A semi-analytical model for transport of dissolved contaminants in the saturated zone.

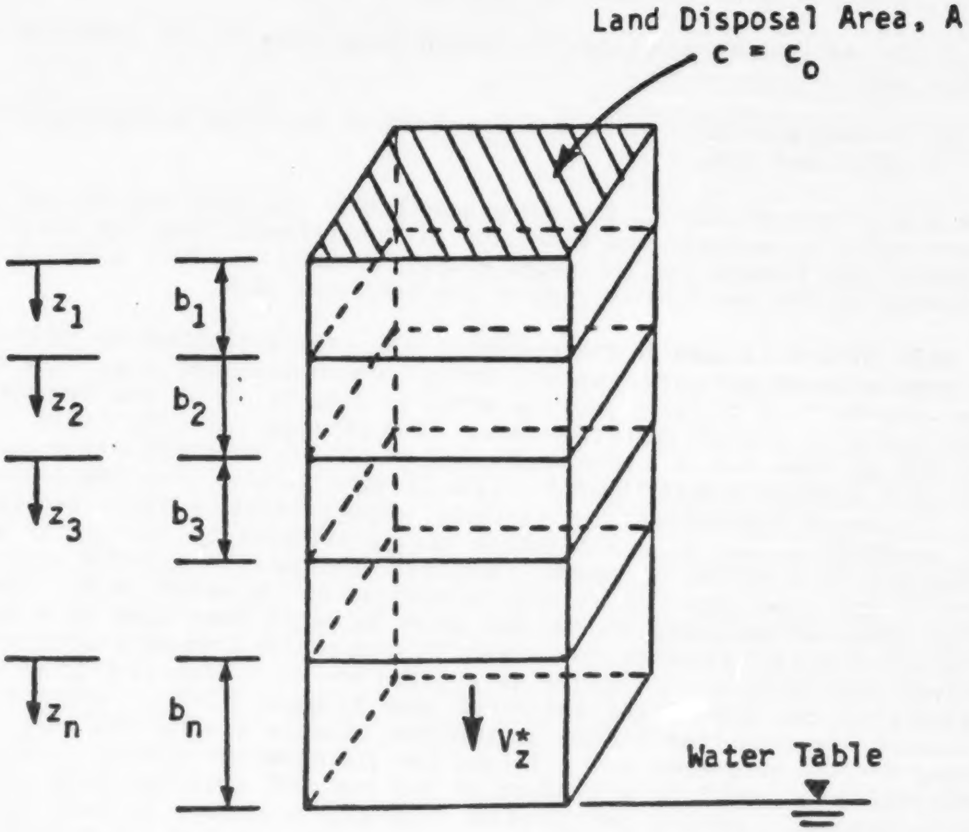
Each module can be used as a stand-alone code or the four modules can be run sequentially to evaluate the migration of contaminants from the surface impoundment and through the saturated zone. In addition, full analysis can be performed for the unsaturated zone or the saturated zone.

When EPACMS is used in the composite mode, the evaluation is initiated by the simulation of moisture movement through the unsaturated zone. The simulation results in a moisture profile which is used to derive the seepage velocity field in the unsaturated zone. The seepage velocity field is then utilized as input for an analytical solution describing steady-state advective transport through a multilayered system (Figure 4.1-2). For the unsaturated zone transport simulation, the variable seepage velocity field derived from the unsaturated zone flow simulation is approximated by taking the average saturation in a series of zones. Vertical transport through the unsaturated zone is then simulated with results determined at the water table. The generated value of concentration at the water table is then used as a boundary condition for the saturated-zone advective-dispersive transport solution. The derived concentration is applied as a patch source of constant concentration boundary of the top of the saturated zone (Figure 4.1-3). After flow and transport are evaluated in the unsaturated zone, a similar analysis is performed for the saturated zone. First, the ground-water velocity field in the saturated zone, which is a product of the regional gradient fluid flux from the impoundment, and any infiltration from precipitation, is generated using an analytical solution. These velocities are then used as input to the saturated zone transport module. The transport module is then used to evaluate advective-dispersive transport of dissolved contaminants in the saturated zone. The final result is a dimensionless concentration, C_D, defined as:

$$C_D = \frac{C_{well}}{C_{source}}$$

FIGURE 4.1-2

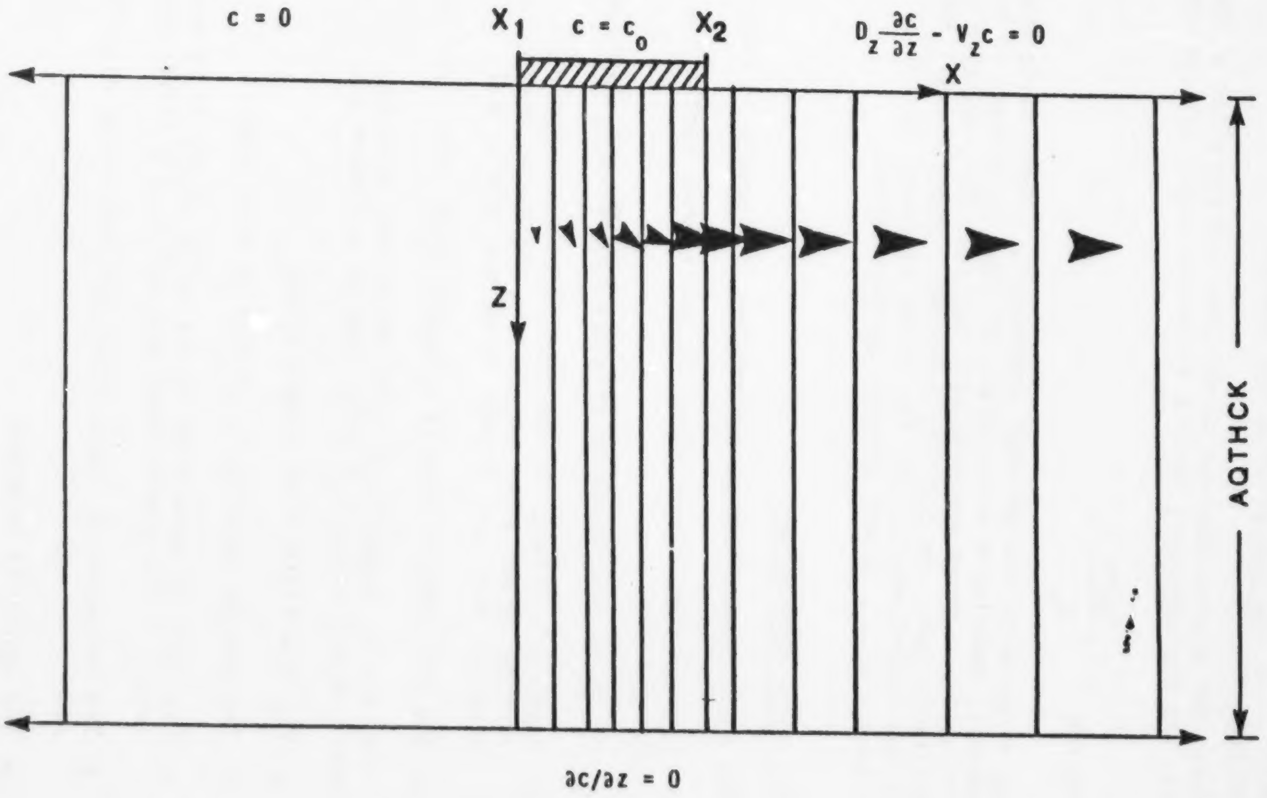
SCHEMATIC OF LAYERED ANALYTICAL SOLUTION FOR TRANSPORT IN THE UNSATURATED ZONE


Land Disposal Area, A
$c = c_o$
z_1
b_1
z_2
b_2
z_3
b_3
z_n
b_n
V_z^*
Water Table

128995

FIGURE 4.1-3

SCHEMATIC DESCRIPTION OF
SATURATED ZONE TRANSPORT MODEL



$c = 0$
X_1
$c = c_0$
X_2
$D_z \frac{\partial c}{\partial z} - V_z c = 0$
X
Z
AQTHCK
$\partial c/\partial z = 0$

where:

C_D = dimensionless concentration
C_{well} = concentration at the exposure point (e.g., water supply well)
C_{source} = concentration at the source.

Therefore, for a given maximum permissible concentration at the exposure point or well, the corresponding maximum allowable lagoon seepage concentration is:

$$C_{source} = \frac{C_{well}}{C_D}$$

For purposes of the national assessment, a Monte Carlo driver was added to the process, enabling a wide variety of input parameters to be taken into consideration for a given hydrogeologic region. The resulting output, C_D, is in probabilistic form. By assuming a maximum acceptable well concentration, this output was transformed (using the above equation) to reflect maximum permissible source (i.e., lagoon seepage) concentrations.

4.1.2.3 Model Assumptions

The major assumptions upon which the flow module is based include:

- Flow of the fluid phase is considered isothermal and governed by Darcy's Law;
- The fluid considered is slightly compressible and homogeneous;
- Hysteresis effects in the constitutive relationships of relative permeability versus water saturation, and water saturation versus capillary pressure head, are assumed to be negligible; and
- The simultaneous flow of a second phase (i.e., air) can be disregarded.

The simplifying assumptions upon which the solutions for advective solute transport in a multilayered porous medium are based are as follows:

- The flow field is at steady state;
- The seepage velocity is uniform in each layer;
- The rate of adsorption by the solid matrix is related to concentration levels in the ground water and matrix by a linear isotherm;
- The influence of longitudinal and transverse dispersion is negligible; and
- The source is constant.

The saturated zone analytical solution for ground-water flow is based on a number of simplifying assumptions pertaining to the geometry and material properties of the saturated zone. The key assumptions are as follows:

- The saturated thickness of the aquifer remains constant despite the fact that mounding occurs;
- The aquifer is homogeneous;
- Ground-water flow is steady;
- Flow is isothermal and governed by Darcy's Law; and
- The fluid is slightly compressible and homogeneous.

The major simplifying assumptions upon which the solutions for advective-dispersive solute transport used in the saturated zone analysis are based include:

- The flow field is at steady state;
- The seepage velocity is uniform in each set-up;
- The rate of adsorption by the solid matrix is related to concentration levels in the ground-water matrix by a linear isotherm;
- The source is constant;
- Each strip is homogeneous and isotropic;
- Each strip is approximated as infinite in horizontal length and therefore the ratio of horizontal dispersivity to strip width for cases where horizontal flow is dominant should be >>1; and
- For the constant concentration boundary condition, the amount of mass entering the system via vertical dispersion is much smaller than by advection. (This assumption may be invalid for cases where the ratio of horizontal to vertical velocity is large).

4.1.3 DETERMINATION OF MODEL INPUT DATA

As shown in Figure 2-1 of the text, the first step in the Monte Carlo method is generation of a problem set, or assembly of a complete set of input parameter values. Individual values are selected at random based on their frequency distributions and interrelationships. Table 4.1-4 lists the required input parameters and their distribution type, as selected for this study. In applying the EPACMS model to the municipal lagoon study, certain modifications to the general input structure were needed to represent the nature of the data available and the problems and issues specific to lagoon systems. The approaches used to identify and define these values are discussed below.

TABLE 4.1-4

SUMMARY OF EPACMS INPUT DATA
(Saturated Zone)

Parameter (units)	Symbol	Distribution Type
Mean particle diameter of the aquifer medium (cm)	d	Log_{10} uniform
Hydraulic gradient (%)	s	Exponential
Thickness of the saturated zone (m)	B	Exponential
Ground-water pH (standard units)	pH	Normal
Ground-water temperature (^{o}C)	T	Normal
Net infiltration (m/yr)	FLUXI	Uniform
Lagoon seepage rate (m/yr)	q	Uniform
Fractional organic carbon content of subsurface environment	f_{oc}	"Johnson SB Distribution"
Hydrolysis constants		
Acid-catalyzed (mole^{-1}hr^{-1})	K_a	Single value, chemical-specific
Neutral (hr^{-1})	K_n	Single value, chemical-specific
Base-catalyzed (mole^{-1}hr^{-1})	K_b	Single value, chemical-specific
Anaerobic biodegradation constant (second^{-1})	-	Single value, chemical-specific
Normalized distribution coefficient for organic carbon (mg/l)	K	Single value, chemical-specific
Lagoon area (m^2)	A	Non-standard distribution (see Section 6.4.3)
Distance to exposure point, measured from downgradient edge of lagoon (m)	X	Non-standard distribution (see Section 6.4.3)
Longitudinal dispersivity (m)	α_L	Defined as a function of distance to the exposure point: $\alpha_L = 0.1(X)$
Vertical dispersivity (m)	α_Z	Defined as a function of α_L: $\alpha_Z = c\alpha_L$ where $0.025 \leq c \leq 0.10$

4.1.3.1 Hydrogeologic Parameters

The vulnerability of each hydrogeologic setting region and subregion of the DRASTIC System (Chapter 2 of the text) to ground-water pollution is indexed by key factors controlling the migration of pollutants from the land surface to the ground-water table. The acronym DRASTIC was formed from the following key factors:

D = Depth to water
R = Recharge (net)
A = Aquifer media
S = Soil media
T = Topography (slope)
I = Impact of vadose zone
C = Conductivity (hydraulic) to the aquifer

Each factor is weighted for its relative importance with respect to other factors and rated by its likely effect on ground-water pollution potential. The product of the weight and rating for each factor is then added to generate the DRASTIC index for a specific setting. Thus, the higher the DRASTIC index, the higher the ground-water pollution potential (or the increase in ease with which the pollutant on the land surface reaches the ground-water table). The DRASTIC index does not provide the impact of ground-water pollution directly. The impact of ground-water pollution could be indexed to key risk factors as given by the acronym IMPACT.

I = Inclination of the water table (gradient)
M = Measured horizontal distance to the exposure point
P = Population exposed
A = Application rate of pollutants
C = Concentration of pollutants
T = Toxicity of pollutants

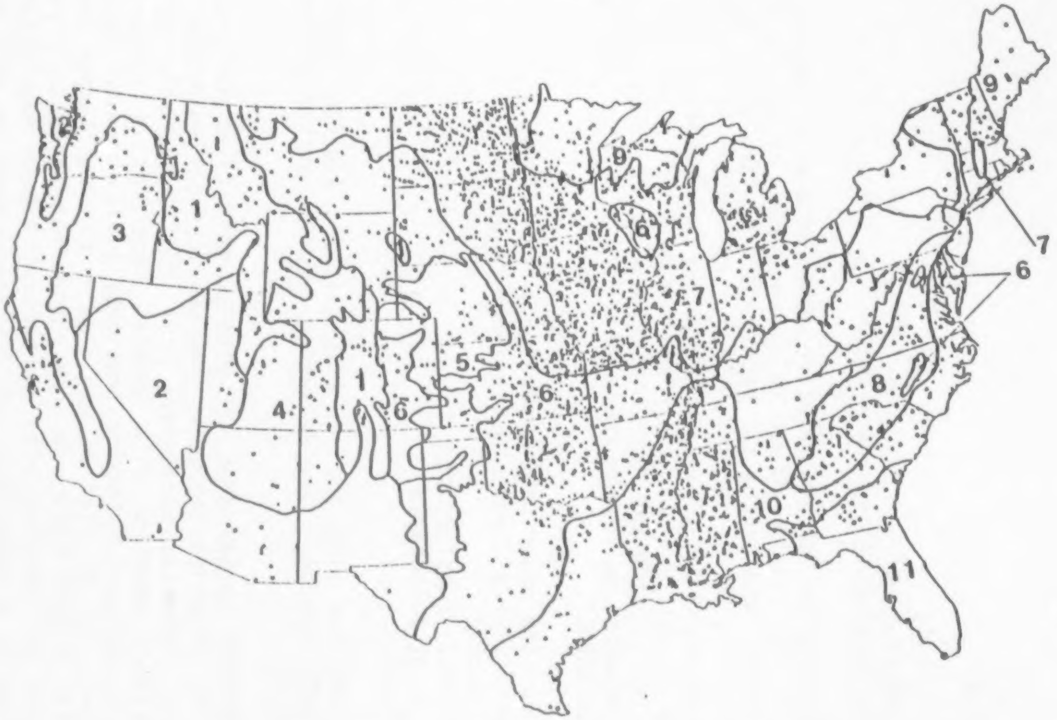
The IMPACT factors are site and facility-specific and therefore are not provided in the DRASTIC system. (See Reference 2 for a further description of the DRASTIC system.)

Although the DRASTIC system does not provide sufficient information for the evaluation of the potential impact of ground-water contamination in terms of human health risk, selected parameters from DRASTIC (notably aquifer and hydraulic conductivity), combined with general knowledge of topography and assumptions regarding regional hydraulic gradients (which control the velocity of ground-water flow), can be used as key inputs for the lagoon study. In addition, the DRASTIC classification of the entire nation into unique hydrogeologic settings can be compared with the actual lagoon population within each setting, leading to a systematic national assessment as well as to the identification of potential problematic situations.

In an effort to concentrate the hydrogeologic scope of this project on those areas with significant lagoon populations, the DRASTIC map was superimposed on a lagoon distribution map, thus identifying the DRASTIC regions with high lagoon populations (see Figure 4.1-4). As a result, seven major

FIGURE 4.1-4

LAGOON POPULATION WITH DRASTIC GROUNDWATER REGIONS



LEGEND :

1 WESTERN MOUNTAIN RANGES
2 ALLUVIAL BASINS
3 COLUMBIA LAVA PLATEAU
4 COLORADO PLATEAU AND WYOMING BASIN
5 HIGH PLAINS
6 NONGLACIATED CENTRAL REGION
7 GLACIATED CENTRAL REGION
8 PIEDMONT AND BLUE RIDGE
9 NORTHEAST AND SUPERIOR UPLANDS
10 ATLANTIC AND GULF COASTAL PLAIN
11 SOUTHEAST COASTAL PLAIN

FACILITY FLOW GROUPS

+	0/99.99 TGD
△	100/499.99 TGD
✿	500/999.99 TCD
)(	> 1000 TGD

DRASTIC regions with high lagoon concentrations were were selected for evaluation. These major DRASTIC regions are mainly in the central United States, but several regions extend to encompass areas of lower lagoon density. The 15 DRASTIC regions, including the seven selected regions, are listed in Table 4.1-5.

Each DRASTIC region is divided into subregions which represent the various hydrogeologic settings typically found in the region. For example, DRASTIC Region 5 consists of hydrogeologic settings 5A (Ogallala), 5B (Alluvium), 5C (Sand Dunes), 5D (Playa Lakes), and 5E (Braided River Deposits). These hydrogeologic settings were individually analyzed to characterize them by their hydraulic conductivity range, aquifer media, and geomorphological features. Once this analysis was accomplished, those settings with similar characteristics were regrouped into nine larger categories containing comparable ranges of hydrogeologic parameters. Table 4.1-6 lists the new categories and their associated settings.

Next, the hydrogeologic data for each category were compiled for input to EPACMS. These parameters include (see Table 4.1-4).

- mean particle diameter of the aquifer medium
- hydraulic gradient (slope of the water table)
- thickness of the saturated zone
- net infiltration (net precipitation recharge)

Estimated ground-water velocities for the nine categories are presented in Table 4.1-7.

Other subsurface parameters listed in Table 4.1-4 (e.g., ground-water pH and temperature, subsurface fractional organic carbon content, etc.) were the same for all hydrogeologic categories.

A third class of parameters, longitudinal and vertical dispersivities, was originally defined as functions of distance to the exposure point (see Table 4.1-4). For this study, the definition of the two parameters was modified to reflect more accurately realistic situations.

This modification involved the division of dispersivity into two categories: under the source (i.e., lagoon) and outside the source (i.e., downgradient from the lagoon). To ensure a constant rate of mass (i.e., pollutant) entering the aquifer from the source with each Monte Carlo iteration, dispersivity was held constant underneath the source. This was accomplished by defining longitudinal dispersivity under the source as a function of lagoon area:

$$\alpha_L = 0.5 (\sqrt{A})$$

The definition of longitudinal dispersivity downgradient from the source was left unchanged, except for the specification of a maximum value of 60 meters, corresponding to commonly encountered regional values (3). As a result of these modifications, the corresponding values of vertical dispersivities (α_z) changed, although the definition of α_z remained the same.

TABLE 4.1-5

DRASTIC REGIONS

Region Number	Region Name
1	Western Mountain Ranges
2*	Alluvial Basins
3	Columbia Lava Plateau
4	Colorado Plateau and Wyoming Basin
5*	High Plains
6*	Nonglaciated Central Region
7*	Glaciated Central Region
8*	Piedmont and Blue Ridge
9*	Northeast and Superior Uplands
10*	Atlantic and Gulf-Coastal Plain
11	Southeast Coastal Plain
12	Alluvial Valleys
13	Hawaiian Islands
14	Alaska
15	Puerto Rico and Virgin Islands

Source: Reference 2

* Regions selected for the municipal lagoon study based on lagoon population.

TABLE 4.1-6

HYDROGEOLOGIC CATEGORIES AND SETTINGS

Category	Setting Number	Setting Name
1	2E	Playa Lakes
	5A	Ogallala
	5D	Playa Lakes
	6B	Alluvial Mountain Valleys
	7Ea	River Alluvium with Overbank Deposit
	7Eb	River Alluvium without Overbank Deposit
	9B	Alluvial Mountain Valleys
	9F	Moraine
	10Ab	Shallow Surficial Aquifers
	10Ba	River Alluvium with Overbank Deposit
2	2B	Alluvial Mountain Valleys
	2C	Alluvial Fans
	2D	Alluvial Basins (Internal Drainage)
	5B	Alluvium
	7C	Moraine
	8B	Alluvial Mountain Valleys
	10Aa	Confined Regional Aquifers
3	5C	Sand Dunes
4	5E	Braided River Deposits
	6Fa	River Alluvium with Overbank
	6Fb	River Alluvium without Overbank
	6G	Braided River Deposits
	7Ab	Glacial Till over Outwash
	7Ba	Outwash
	7D	Buried Valley
	7H	Beaches, Beach Ridges, and Sand Dunes
	8E	River Alluvium
	9Db	Glacial Till over Outwash
	9E	Outwash
	9Ga	River Alluvium with Overbank
	9Gb	River Alluvium without Overbank
	10Bb	River Alluvium without Overbank Deposit
	10C	Swamp
5	7Aa	Glacial Till over Bedded Sedimentary Rocks
	7Bb	Outwash over Bedded Sedimentary Rocks
	7F	Glacial Lake Deposits
	7G	Thin Till over Bedded Sedimentary Rocks
	8C	Mountain Flanks
	9C	Mountain Flanks
6	6A	Mountain Slopes
	6C	Mountain Flanks
	6Da	Alternating Sandstone, Limestone, and Shale-thin Soil
	6Db	Alternating Sandstone, Limestone, and Shale-deep Regolith
7	6H	Triassic Basins
8	7Ad	Glacial Till over Sandstone
9	7Ae	Glacial Till over Shale

TABLE 4.1-7

ESTIMATED GROUND-WATER VELOCITY FOR THE NINE HYDROGEOLOGIC CATEGORIES

Category	Estimated Ground-Water Velocity (m/yr)[a]
1	25 - 364
2	10 - 251
3	76 - 760
4	36 - 760
5	32 - 203
6	0.3 - 64
7	0.1 - 48
8	51 - 376
9	0.1 - 48

[a] Estimated on the basis of hydraulic conductivity and hydraulic gradient.

4.1.3.2 Lagoon Seepage Rates

An assessment of potential seepage rates from lagoon systems was made to establish a range of hydraulic loadings for input into the EPACMS model. This assessment focuses on seepage from lagoons through permeable liners and unlined lagoons. The effects of accumulated sludge and self-sealing are also addressed. (Synthetic liners are considered to be essentially impermeable and are therefore not included in this analysis).

4.1.3.2.1 Theoretical Calculation of Seepage Rates. The rate of seepage from lagoons is dependent on the water depth, liner hydraulic conductivity and liner thickness and can be calculated from the rate of flow in saturated media using Darcy's Law (4):

$$v = K\,(dh/dl)$$

where

v = Darcy's velocity (length/time)
K = hydraulic conductivity coefficient (length/time)
dh/dl = hydraulic gradient

Figure 4.1-5 presents a schematic of a lagoon system with water depth (D) and a liner of known hydraulic conductivity (K) and thickness (t). Assuming: (1) the liner is completely saturated; (2) the underlying aquifer has an hydraulic conductivity greater than that of the liner; (3) the ground-water table is below the liner; and (4) accumulated sludge does not affect seepage, then the seepage equation developed from Darcy's law is:

$$S = \frac{K(D+t)}{t}$$

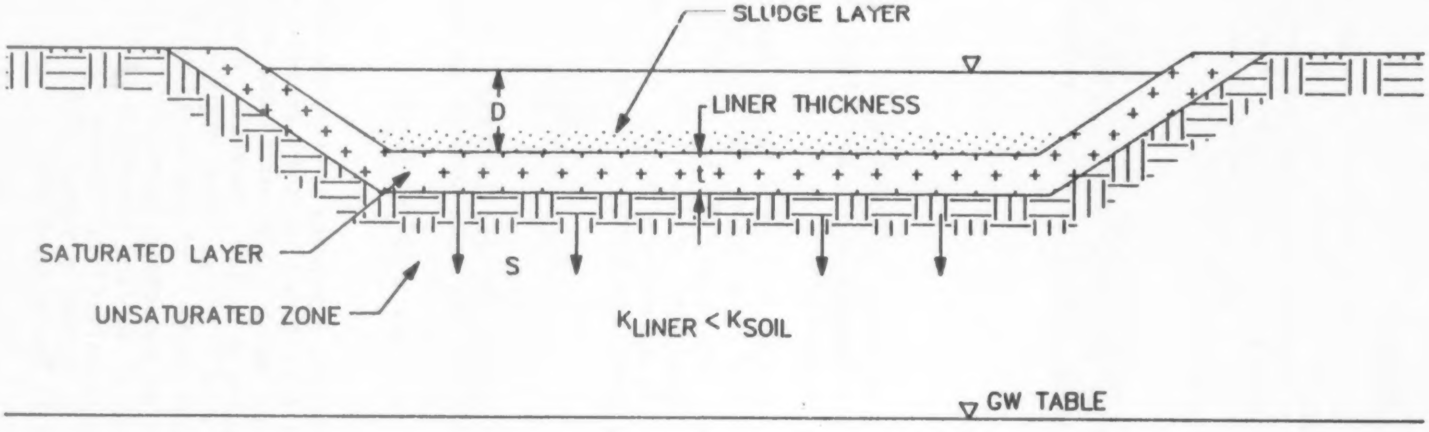
For seepage, S, in inches per day (in/day), K in centimeters per second (cm/sec), and D, t in feet (ft), the seepage equation becomes:

$$S = 3.4 \times 10^{4}\,K\,\frac{(D+t)}{t}$$

Figure 4.1-6 presents a summary of seepage rates for various water depths and liner characteristics based on this seepage equation. To illustrate, a lagoon having a 10-foot water depth would seep at 0.04 in/day through a 1-foot thick clay liner having $K = 10^{-7}$ cm/sec. However, for a 3-foot compacted earth liner with $K = 10^{-5}$ cm/sec, the seepage rate would be 1.47 inches per day at a 10-foot water depth. If the water table is above the bottom of the liner, seepage would be reduced proportionally to the change in head between the water table and water surface elevation in the lagoon. Therefore, for the identified liner characteristics, Figure 4.1-6 represents maximum expected seepage rates from a lagoon system. Typical permeabilities for various liners are presented in Table 4.1-8 (5).

FIGURE 4.1-5

SCHEMATIC OF SEEPAGE THROUGH A LAGOON LINER


SLUDGE LAYER
D
LINER THICKNESS
t
SATURATED LAYER
S
UNSATURATED ZONE
$K_{LINER} < K_{SOIL}$
GW TABLE

128995

FIGURE 4.1-6
SEEPAGE AS FUNCTION OF WATER DEPTH AND LINER CHARACTERISTICS

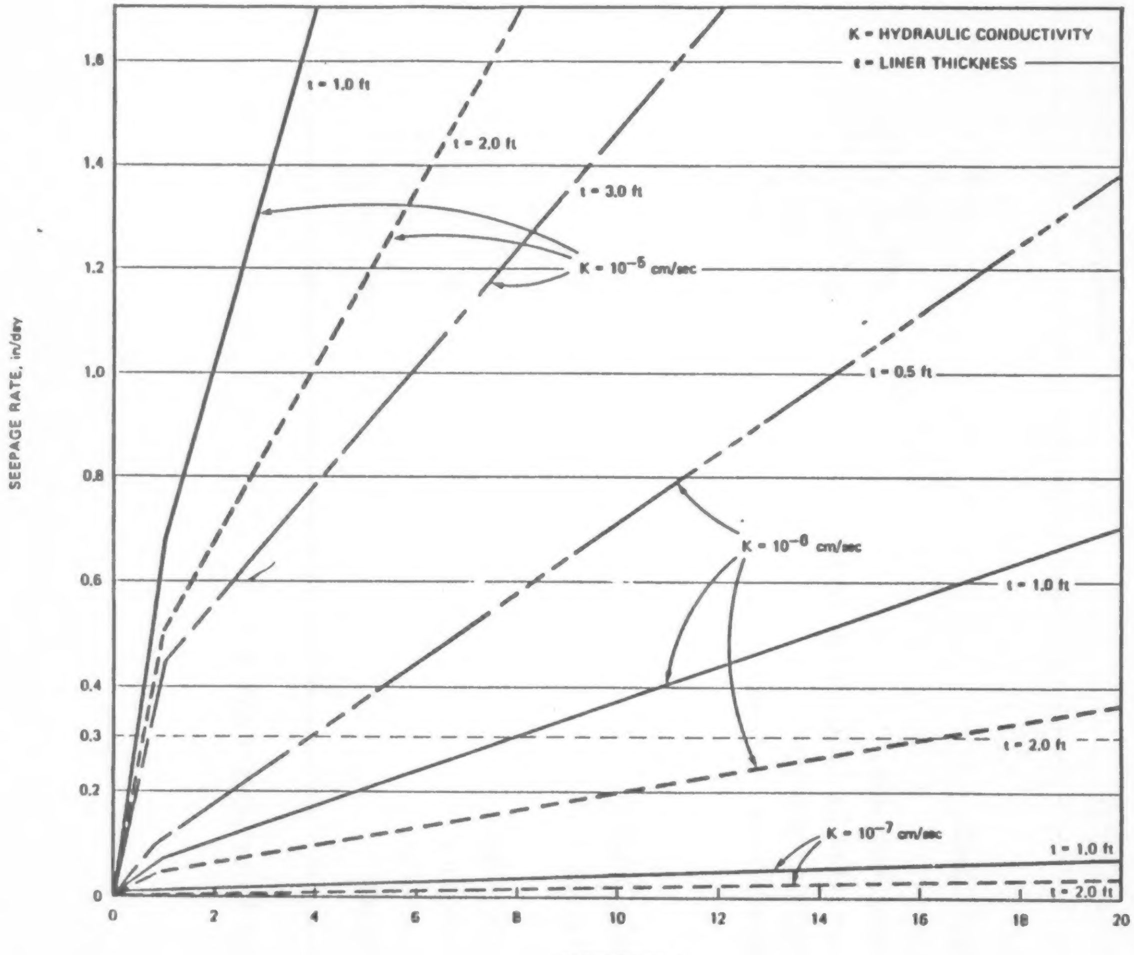


TABLE 4.1-8

PERMEABILITY OF VARIOUS LINERS AND GEOLOGIC MATERIALS

Material	Permeability (cm/s)
Liner	
Soil cement	10^{-6}
Gunite	10^{-7}
Compacted clay	10^{-6} to 10^{-10}
Compacted bentonite plus earth	10^{-6} to 10^{-8}
Asphalt concrete	10^{-7}
Unreinforced concrete	10^{-6}
Geologic Material	
Glacial till	10^{-4} to 10^{-10}
Clay	10^{-6} to 10^{-10}
Silt, loose	10^{-3} to 10^{-7}
Silt sand	10^{-1} to 10^{-5}
Clean sand	1 to 10^{-4}
Gravel	10^{2} to 10^{-1}

Source: References 4 and 5.

Application of the permeabilities in Table 4.1-8 to Figure 4.1-6 for the range of water depths typical of lagoon systems (4 to 20 ft) indicates that for readily available liner materials ($K = 10^{-6}$ to 10^{-7} cm/sec), seepage rates can vary from less than 0.01 in/day to 1.4 in/day. This represents a variation of over two orders of magnitude. However, the maximum seepage rate can be reduced to less than 0.1 in/day by a liner with $K = 10^{-7}$ cm/sec and a thickness of one foot. This is representative of a typical bentonite clay liner design.

For unlined lagoons, seepage rates are dependent on the hydraulic conductivity of the native soil (excluding the effects of an overlying sludge layer). Freeze and Cherry (4) have compiled ranges for various consolidated geologic deposits (shown in Table 4.1-8). Assuming that a compacted native earth liner decreases the hydraulic conductivity 1 to 2 orders of magnitude, seepage rates determined from Figure 4.1.6 would be in excess of 2 in/day for gravelly, sand and silt aquifers (depending also on the depth of water in the lagoon and thickness of the compacted earth layer).

4.1.3.2.2 Effects of the Sludge Layer. Table 4.1-9 presents a summary of measured seepage rates from unlined municipal lagoon systems which are known to have a sludge layer. These data indicate the relative impact of a sludge layer on lagoon seepage caused by self-sealing mechanisms, such as physical, chemical and biological clogging. Seepage rates range from 0.04 to 1.3 inches per day (1,000 to 35,300 gallons per day per acre, gpd/ac) and reflect hydraulic characteristics of both the sludge layer and underlying soils.

The thickness of the sludge layer, sludge/soil hydraulic conductivity, and location of the water table were not measured for the lagoon systems referenced in Table 4.1-9. However, the data in Table 4.1-9 indicate the presence of a sludge layer that significantly reduces the expected rate of seepage. In four studies of lagoon systems located in sandy soils, expected seepage rates greater than 2 in/day were reduced to values of 0.35, 0.34, 0.18, and 0.12 in/day, respectively, presumably due to the effect of a sludge layer. In more permeable silt, sands, and gravels, seepage rates of 0.61 to 1.3 in/day occurred through the sludge layer. These data suggest that the degree of self-sealing is dependent on the underlying geologic media.

Intensive studies of seepage from lagoons in Minnesota suggest that the hydraulic conductivity of permeable soils may be decreased one to two orders of magnitude by the accumulation of a sludge layer. However, fluctuations in the water table above the bottom of the lagoon system may also be the cause of the reduced seepage as noted in these studies (6). The measured soil/sludge hydraulic conductivity was approximately 10^{-6} cm/sec. Therefore, for a 1-foot sludge/soil liner, the seepage rate would be 0.37 in/day at a 10-foot water depth (see Figure 4.1-6).

The rate and extent of sludge deposition significantly affects seepage from unlined lagoon systems. For at least three cases (multiple cell systems, lagoons receiving primary effluent, and intermittently used lagoons) the degree of sealing will vary widely. Thus there is much uncertainty in applying seepage rates to the total area of a lagoon system, or even a single lagoon, as sludge may settle out near the influent pipe. Data on berm and/or

TABLE 4.1-9

SUMMARY OF MEASURED SEEPAGE RATES FROM MUNICIPAL LAGOON SYSTEMS

Water depth (feet)	Lagoon Type	Underlying Soil	Seepage Rate in/day	Seepage Rate gpd/ac	Reference
5	Facultative	Heavy silty clay	0.3	8,200	7
6	Facultative	Light silty clay	0.29	7,900	7
5	Facultative	Alkaline silt	0.65	17,700	7
6	Facultative	Fine sand	1.2	32,600	7
6	Facultative	Gravel and silt	1.3	35,300	7
-	-	Sandy soil	0.35	9,500	8
-	-	Sand and gravel	0.61[a]	16,600	8
-	-	Sandy soil	0.34	9,300	8
-	-	Clay loam and shale	0.3	8,200	8
-	Maturation	Mica and schist	0.06-0.23	1,700-6,300	8
5	Facultative	Silt, sand, marl	0.18	5,000	9
5	Facultative[b]	Sand, silt, marl	1.07	29,000	9
5	Evaporation[c]	Sand, silt, marl	0.04-0.11	1,000-3,000	10
-	Facultative	Sandy soil	0.12	3,400	10

Source: References 7, 8, 9, and 10.

[a] Includes net precipitation/evaporation.
[b] Used intermittently.
[c] Sealed with bentonite and soda ash.

liner compaction specifications and actual construction practices collected during the lagoon sampling program were very limited. In many cases, it appears that only berm compaction (for structural stability) was provided. Compaction of lagoon bottoms to prevent seepage apparently was not always required.

4.1.3.2.3 Selection of Lagoon Seepage Rates for the National Assessment. Of the 23 municipal lagoons investigated as part of this assignment, 8 had liners, 2 had compacted native clay liners, and 13 were unlined or consisted of compacted native soils (see Tables 3-3 and 3-4 in the text). Table 4.1-10 presents an hydraulic balance for each of the nine domestic lagoons sampled (and Mandan, ND) based on hydrogeologic, liner, and flow information obtained during the field investigation. The resulting seepage rates estimated for these ten systems vary between 0.03 and 1.2 in/day (excluding the percolation beds at the Laramie, WY site), and represent 5 to 48 percent of the influent hydraulic load. (Honeybrook, PA experienced an increase in discharge caused by positive net precipitation, resulting in an effective seepage rate of 1% of the influent loading.)

Table 4.1-11 presents a summary of State seepage and permeability limitations for lagoon systems. Thirty-four States have limitations; 24 States designate allowable seepage rates, 8 States limit maximum hydraulic conductivities, and two States, Washington and Virginia, regulate both seepage and liner permeability. Eleven States follow the "Ten State Standards" seepage rate of 500 gpd/ac (0.02 in/day), based on a 6-foot water depth (11). Conversion of these conditions to a 20-foot water column would result in a seepage rate of 0.06 in/day. Allowable seepage rates vary between 0.02 and 0.25 in/day (1/64 to 1/4 in/day) or 500 to 6,800 gpd/ac. Allowable liner permeabilities vary between 10^{-6} and 10^{-8} cm/sec (Alabama requires 10^{-12} cm/sec for synthetic liners), with 7 States requiring 10^{-7} cm/sec. Many of these limitations have only recently been enacted. In 1978, only 16 States limited seepage from lagoon systems (5), and the Ten States Standard of 500 gpd/ac was just then implemented.

Based on the assessment of potential seepage rates from lagoon systems (Tables 4.1-9 and 4.1-10), a range of seepage rates, from 0.1 to 0.3 in/day, uniformly distributed, was selected for use in computer modelling. While the low end of state seepage limitations, 0.02 in/day for a 6-foot water column (corresponding to 0.06 in/day for a 30-foot water column), is achievable with standard materials and construction practices currently available, it is not likely that a high proportion of existing lagoons conforms to this value. Below these values, synthetic liners would result in virtual impermeability (less than 0.001 in/day).

The 0.3 in/day value is at the upper limit of State limitations (0.25 in/day) and represents a reasonable sludge-layer limiting value for unlined lagoons under many geologic conditions. For the majority of lagoon systems, values greater than 0.3 in/day would result in the majority of the influent wastewater being disposed of via seepage. Therefore, use of seepage rates greater than 0.3 in/day for computer modelling would simulate estimated upper bound worst-case conditions for domestic and domestic/industrial lagoon scenarios, beyond the range of reasonable values.

TABLE 4.1-10

ESTIMATED SEEPAGE RATES AND HYDRAULIC BALANCES AT 10 LAGOONS
(9 Domestic, 1 Domestic/Industrial)

Site/Liner Type	Influent Flow, Q_i		Seepage Rate			Net P/E[a]	Effluent Flow, Q_e
	mgd	in/day	in/day	gpd/acre	% Q_i	in/day	% Q_i
Laramie, WY							
Bentonite sealer	4.2	8.6	1.2	32,600	14	-0.08	85
Percolation beds	3.6	3.6	3.6	97,800	100	-0.08	0
Honeybrook, PA							
Double bentonite	0.6	2.33	0.024	650	1	+0.04	101
Potterville, MI							
2-ft clay seal	0.45	0.58	0.027	750	5	0	95
Standish, MI							
Compacted clay soil	0.3	0.34	0.125	3,400	37	0	63
Britton Village, MI							
Compacted clay soil	0.19	0.35	0.17	4,600	48	+0.01	54
Buffalo, WY							
Bentonite	1.3	1.37	0.032	850	2	-0.07	93
Lander, WY							
Bentonite	2.0	1.05	0.034	900	3	-0.06	91
Mandan, ND							
Compacted earth	1.5	1.94	0.37	10,050	19	-0.05	78
Minot, ND							
Bentonite (assumed)	3.5	0.18	0.03	800	17	-0.05	55
McVille, ND							
Compacted earth	0.06	0.74	0.3	8,150	41	-0.02	57
Unlined/sand	0.036	0.42	>0.5	>13,600	100	-0.02	0

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[a] Daily net Precipitation (+)/Evaporation (-) based on annual average (P-E).
[b] Includes effect of percolation and net P/E.

TABLE 4.1-11

SUMMARY OF STATE SEEPAGE AND PERMEABILITY LIMITATIONS FOR LAGOON SYSTEMS

State	Permeability K (cm/sec)	Seepage in/day	Seepage gpd/acre
Alabama	10^{-7} (Earthen liner) 10^{-12} (Synthetic liner)		
Arkansas		0.02	500[a]
Colorado		0.03	850
Delaware		0.02	500[a]
Georgia		0.12	3,400
Idaho		0.25	6,800
Indiana	10^{-7}		
Iowa		0.06[b]	1,700
Kansas		0.25	6,800
Kentucky		0.02	500[a]
Maine		0.02	500[a]
Maryland	10^{-8}		
Michigan		0.12	3,400
Minnesota		0.02	500[a]
Mississippi		0.02	500[a]
Missouri		0.25	6,800
Montana			
Primary		0.02	500[a]
Secondary		0.04	1,200
Nebraska		0.25	6,800
New Hampshire		0.02	500
New Jersey	10^{-7}		
New York		0.02	500[a]
North Carolina	10^{-6}[c]		
North Dakota		0.12	3,400
Ohio		0.02	500[a]
Oklahoma	10^{-7}		
Oregon		0.25	6,800
Pennsylvania	10^{-7}		
South Carolina		0.02	500[a]
South Dakota			
Primary		0.06	1,700
Secondary		0.12	3,400
Utah		0.25	6,800
Virginia	10^{-6}		
Washington	10^{-7}	0.25	6,800
Wisconsin	10^{-7} (Soil and bentonite liners)	0.04	1,000
Wyoming		0.12	3,400

[a] Ten State Standard based on 6-foot water depth (11).
[b] Based on 6-foot thickness.
[c] Minimum 1-foot thickness, compacted on-site soils.

4.1.3.3 Lagoon Area and Exposure Distance

In the original use of EPACMS and preceding models, both lagoon area and distance to the nearest exposure point were entered as single values. For this project, a Monte Carlo approach was selected to reflect more accurately the realistic variation of those two parameters. To this end, data on both lagoon area and exposure distance were obtained from sample populations and compiled to yield frequency distributions, which were then subjected to curve-fitting procedures to determine the most representative probability distributions.

For lagoon area, data were compiled from Table 3-1 (in the text) for domestic lagoons. Data for domestic/industrial lagoons (Table 3-2, text) were not included as they could not be readily combined with domestic lagoon data.

Data for the exposure distance distribution were obtained by selecting a sample lagoon population of 220 lagoons and conducting an exposure mapping exercise to identify distributions of downgradient receptors. This mapping technique is discussed below.

For each lagoon, the distance to the closest downgradient well within 2000 meters was determined from USGS 7.5-minute maps. In measuring the distance to the closest well, both private residential wells and public water supplies were considered, as was the potential for ground-water interception by surface water. Wells located downgradient from a stream that was likely to intercept the contaminant plume from the lagoon were not included. However, in cases where the stream might not intercept all of the plume, wells beyond the stream were included. For the facilities without a potentially affected well within 2,000 meters, exposure was assumed to occur in the 2,000 meters to infinite distance range.

These data are summarized in Table 4.1-12, which gives the probability and cumulative probability distributions for the distance to the closest well at municipal wastewater treatment facilities, based on survey data from 220 facilities. The distribution provides probabilities that a well will be located within one of eight exposure ranges.

As both lagoon area and exposure distance data are reported in incremental terms, an equal probability of occurence must be assumed within a given range. The distributions determined on the basis of this assumption are:

Lagoon Area (square meters, m^2)

$$P(X) = 2.36 \times 10^4 (X^{-2.103})$$

$$10{,}522 \le X \le 943{,}760$$

Exposure Distance (meters, m)

$$P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$$

$$35 \le X \le 2000$$

TABLE 4.1-12

DISTANCE TO NEAREST WELL

Distance Range, X (meters) Lower	Upper	Number of Wells within Distance Range	Probability of Exposure	Cumulative Probability
0	35	4	0.0182	0.0182
36	130	18	0.0818	0.1000
131	300	28	0.1273	0.2273
301	500	35	0.1591	0.3864
501	800	35	0.1591	0.5455
801	1,250	25	0.1136	0.6591
1,251	2,000	17	0.0773	0.7364
2,001	Infinite	58	0.2636	1.0000
		TOTAL: 220	1.0000	

Source: ICF, Inc., 1987

These distributions represent the probability of lagoon area or exposure distance equaling a specific value within the defined range. Details of the distribution derivation are presented in Appendix 4.2.

4.1.3.4 Chemical Constants

The preliminary results of a literature search for values of hydrolysis and other chemical constants required as input to EPACMS are presented as Appendix 4.3. (It should be noted that these values are subject to change, as additional experimental data become available). Because of the large and sometimes diverse number of values obtained for a particular constant, it was necessary to formulate a basis for the selection of a corresponding single value. In general, values of dubious validity (e.g., "estimated from values which were themselves estimated") were discarded and the remaining values averaged. This process is outlined in more detailed form in Appendix 4.3. Table 4.1-13 presents the final values used in the EPACMS computer runs.

Table 4.1-13 shows that none of the pollutants investigated in this study had values for all five constants. In one case, arsenic, no data were available. Although biodegradation is known to occur for some of the other pollutants (e.g., tetrachloroethylene), reliable rate constants were not identified in time for inclusion in the Report to Congress. Where constants were not available or a reaction was considered insignificant, a default value was assumed, indicating no attenuation due to that particular process. The net result of this assumption was the underestimation of retardation or degradation for a particular pollutant.

4.1.4 SELECTION OF GENERIC MODELLING SCENARIOS

As discussed in Sections 4.1.3 and 4.1.1 of this Appendix, nine hydrogeologic categories and seven pollutants were selected for the national assessment. If all combinations were to be investigated using the EPACMS model, a total of 63 runs would be required, covering approximately 90% of the nation's 5,476 lagoons, as shown in Table 4.1-14. The remaining 10% of the lagoons are scattered throughout the Northwest, the Rocky Mountains and Florida (see Table 4.1-5 and Figure 4.1-4 of this Appendix).

TABLE 4.1-13

CHEMICAL CONSTANTS USED IN EPACMS RUNS

Pollutant	K_{oc} (ml/g)	K_a ($\text{mole}^{-1}\text{hour}^{-1}$)	K_n (hr^{-1})	K_b ($\text{mole}^{-1}\text{hour}^{-1}$)	Anaerobic Biodegradation (sec^{-1})
Arsenic	NA[a]	NA	NA	NA	NA
Benzene	59	-[b]	-[b]	-[b]	NA
Beryllium	NA	NA	NA	NA	NA
Chloroform	31	0	3×10^{-9}	0.23	NA
2,4-Dinitrotoluene	76	-[b]	-[b]	-[b]	NA
Hexachlorobenzene	1.5×10^{5}	-[b]	-[b]	-[b]	NA
Nitrate	NA	NA	NA	NA	3.2×10^{-6}
Tetrachloroethylene	209	-[b]	-[b]	-[b]	NA

Source: Appendix 4.3

[a] Not available.
[b] Hydrolysis not significant.

TABLE 4.1-14

NUMBER OF LAGOONS PER HYDROGEOLOGIC CATEGORY[a]

Category	Number of Small Lagoons[b]	Number of Large Lagoons[c]	Number of Total Lagoons
1	894	123	1,017
2	555	99	654
3	23	1	24
4	1,766	149	1,915
5	376	25	401
6	319	26	345
7	255	21	276
8	116	7	123
9	132	8	140
TOTAL	4,436	459	4,895
% OF TOTAL	90.6	9.4	

[a] Because only seven of the 15 DRASTIC regions were included in the study, not all of the nation's 5,476 lagoons are represented in this table.

[b] Flow rates less than 0.5 mgd.

[c] Flow rates greater than or equal to 0.5 mgd.

APPENDIX 4.2

DETERMINATION OF PROBABILITY DISTRIBUTIONS FOR LAGOON AREA AND EXPOSURE DISTANCE

APPENDIX 4.2

DETERMINATION OF PROBABILITY DISTRIBUTIONS FOR LAGOON AREA AND EXPOSURE DISTANCE

A. General Procedure

(1) Take probability of being within a given range and divide it by the size of the range itself. For example, take exposure distances between 0 and 35 meters:

  (a) $0 \leq X \leq 35$; probability = 0.0182

  (b) $(0.0182)/(35-0) = 0.000520$

(2) Do this for all intervals

(3) Plot the resulting data as a step function (e.g., all unit values from 1 to 35 are 0.000520) of probability versus distance

(4) Fit a curve to the endpoints or midpoints of the steps

  (a) Use step endpoint for exposure distance, as lagoons in the 0-35 range are likely to be closer to 35 (also, since there is no upper limit on distances greater than 2000m, it is not possible to define a discrete "step" and assign probabilities to each unit value as done in Item (1) above).

  (b) Use step midpoint for area, as approximately 60% of the lagoons are in the first increment (0 to 5.2 acres)

B. Lagoon Area

(1) Form of equation: $P = AX^B$

(2) Correlation coefficient: $R^2 = 0.97$ (see graph)

(3) Limits are step midpoints: $10{,}522 \leq X \leq 943{,}760$

(4) Equation: $P = 2.36 \times 10^4 \, (X^{-2.103})$

C. Exposure Distance

(1) Form of equation: $P = AX^3 + BX^2 + CX + D$

(2) Correlation coefficient: $R^2 = 0.91$ (see graph)

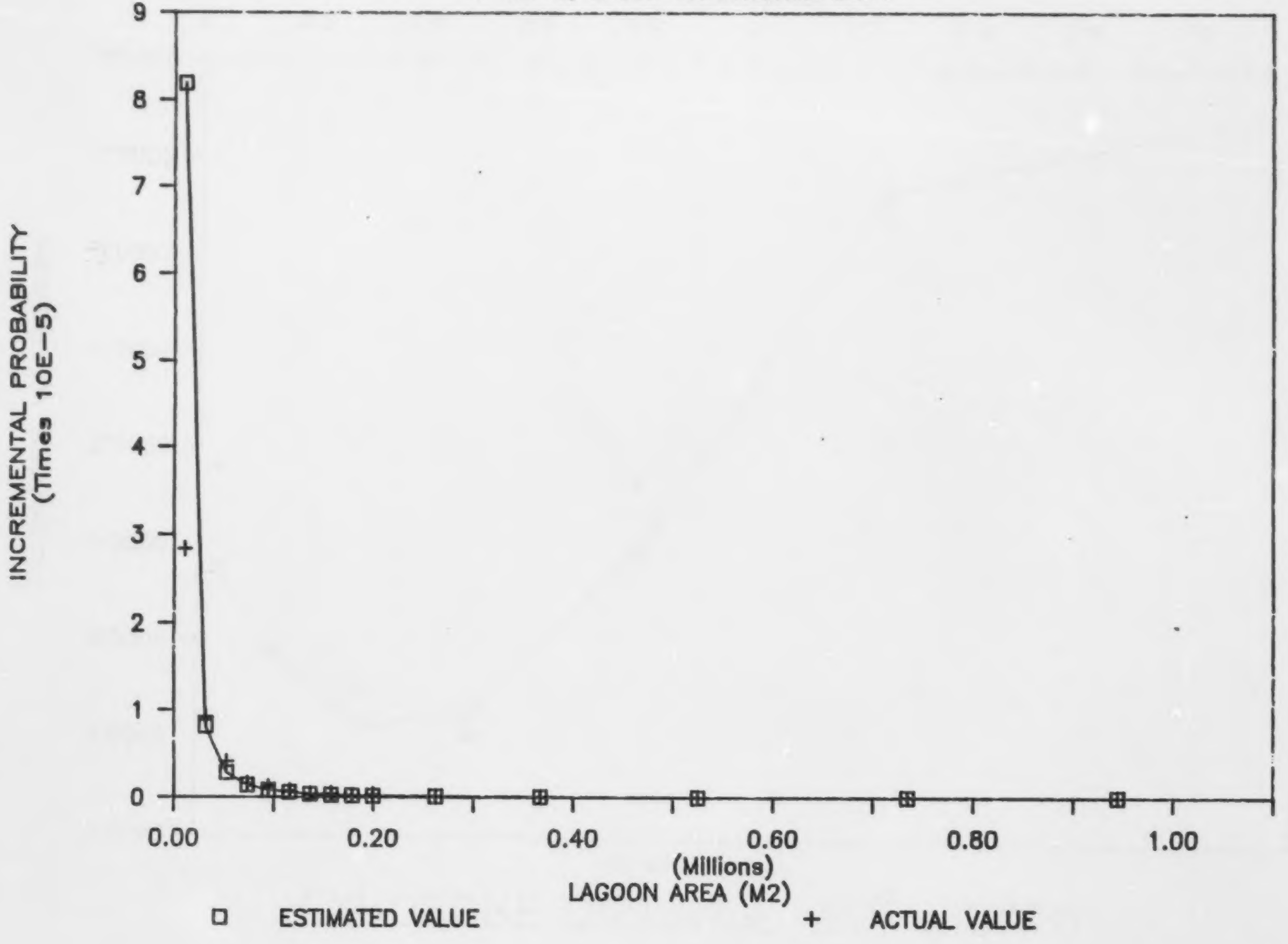
(3) Limits are step endpoints (the step above 2000 has no endpoint): $35 \leq X \leq 2000$

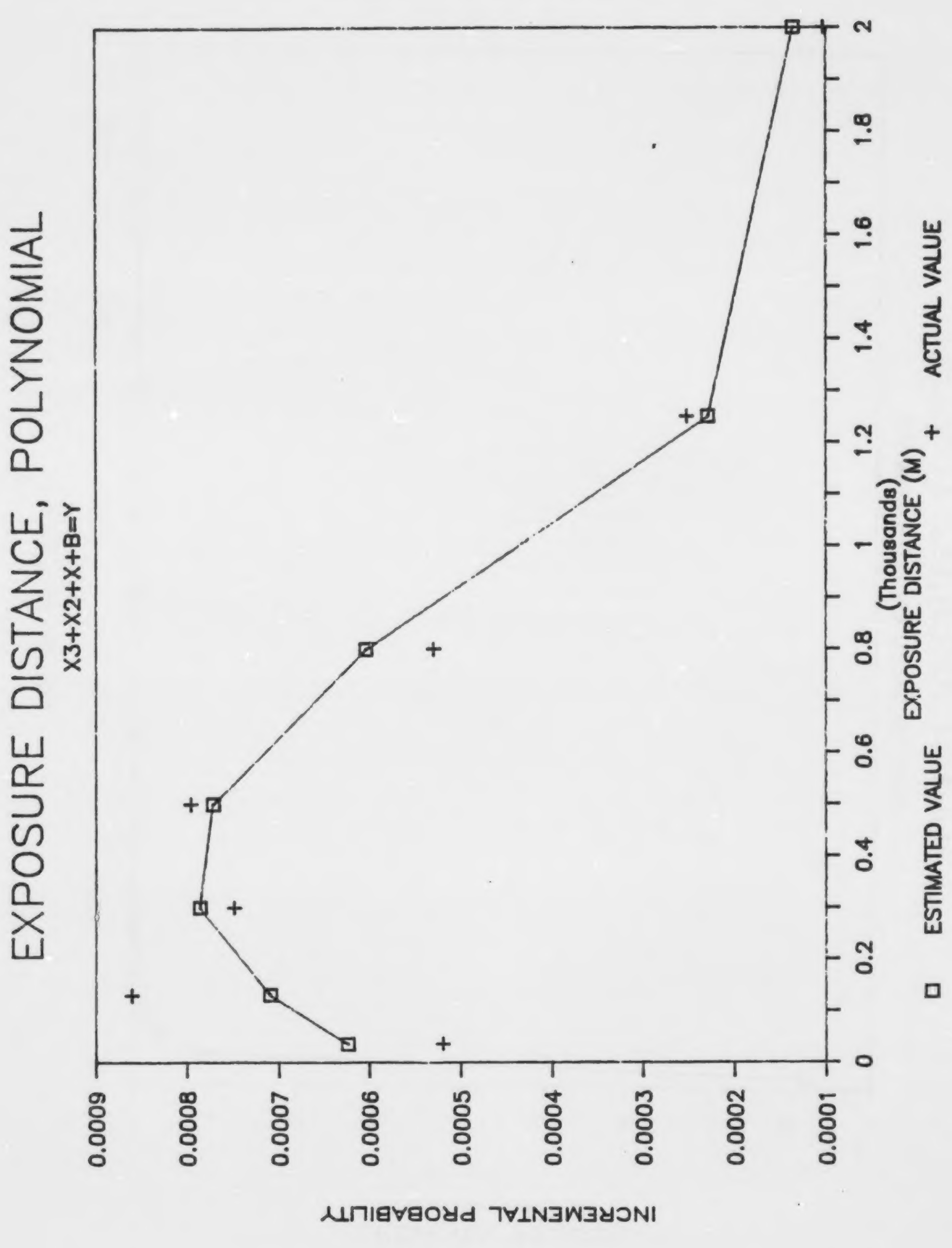
(4) Equation:

$$P = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9}(X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$$

LAGOON AREA,M2 (LN,LN)

P=AX^B; BASED ON INTERVAL MDPT




EXPOSURE DISTANCE, POLYNOMIAL
X3+X2+X+B=Y
INCREMENTAL PROBABILITY
0.0009
0.0008
0.0007
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
(Thousands)
EXPOSURE DISTANCE (M)
□ ESTIMATED VALUE
+ ACTUAL VALUE

APPENDIX 4.3

SELECTION OF CHEMICAL CONSTANTS

APPENDIX 4.3

SELECTION OF CHEMICAL CONSTANTS BASED ON DATA COMPILED BY OSW

CHEMICAL CONSTANTS USED IN EPACMS RUNS

Pollutant	K_{oc} (ml/g)	K_a ($mole^{-1} hour^{-1}$)	K_n (hr^{-1})	K_b ($mole^{-1} hour^{-1}$)	Anaerobic Biodegradation (sec^{-1})
Arsenic	NA[a]	NA	NA	NA	NA
Benzene	59	-[b]	-[b]	-[b]	NA
Beryllium	NA	NA	NA	NA	NA
Chloroform	31	0	$3x10^{-9}$	0.23	NA
2,4-Dinitrotoluene	76	-[b]	-[b]	-[b]	NA
Hexachlorobenzene	$1.5x10^{5}$	-[b]	-[b]	-[b]	NA
Nitrate	NA	NA	NA	NA	$3.2x10^{-6}$
Tetrachloroethylene	209	-[b]	-[b]	-[b]	NA

[a] Not available.

[b] Hydrolysis not significant.

Note 1: Benzene

Organic Carbon Partition Coefficient, K_{OC}

	Value	Source
(a)	93	Estimated from measured data
(b)	920	Experimentally measured for aqueous estuarine colloids
(c)	27.8	Unknown
(d)	65	Estimated from estimated data

- Discard (b) as not relevant to subsurface regime
- Could select (a) only, but it is the highest value and thus the least conservative
- Average (a), (c) and (d)
- Result is 59

Note 2: Chloroform

Organic Carbon Partition Coefficient, K_{OC}

	Value	Source
(a)	31	Estimated from measured data
(b)	34	Estimated from measured data
(c)	44	Estimated from estimated data

- Discard (c)
- Could average (a) and (B), but (a) is found in Superfund Public Health Evaluation Manual and was the only value originally reported for use in initial runs
- Therefore, pick 31

Neutral Hydrolysis Constant, k_n

	Value	Source
(a)	3×10^{-9}	Experimentally measured
(b)	2.5×10^{-9}	Estimated from measured data

- Pick 3×10^{-9} as more reliable (also, only value reported for use in initial runs)

Note 3: 2,4-Dinitrotoluene

Organic Carbon Partition Coefficient, K_{OC}

	Value	Source
(a)	45	Estimated from estimated values
(b)	107.2	Unknown

- Average (a) and (b)
- Result is 76

Note 4: Hexachlorobenzene

Organic Carbon Partition Coefficient, K_{OC}

	Value	Source
(a)	3900	Estimated from measured data
(b)	10^4-10^5	Estimated from measured data
(c)	0.00175	Unknown
(d)	3.954×10^5	Unknown
(e)	1.2×10^6	Estimated from estimated data

- Discard (c) as being suspect
- Discard (e), which is "estimated from estimated data"
- Take median (5×10^4) of the range in (b)
- Average (a), (d) and 5×10^4
- Result is 1.5×10^5

Note 5: Nitrate

Anaerobic Biodegradation Rate Constant

Given the variety of constants compiled (different depths, incubation times, and initial concentrations), it was decided to pick a constant corresponding to the greatest depth and longest incubation time. Three values, 15.6×10^{6}, 4.5×10^{-6}, and 3.2×10^{-6} second $^{-1}$ fit these criteria. The latter value, 3.2×10^{-6}, was selected to reflect a more conservative approach (All data were experimentally measured).

Note 6: Tetrachloroethylene

Organic Carbon Partition Coefficient, K_{OC}

	Value	Source
(a)	209	Estimated from measured data
(b)	229	Estimated from estimated data
(c)	245	Estimated from estimated data
(d)	3.5×10^{-4}	Estimated from estimated data expressed in dimensionless units
(e)	166	Source unknown
(f)	364	Estimated from estimated data

- Discard (d) as being noncomparable
- Discard (b), (c) and (f) which are "estimated from estimated values"
- Discard (e) as being unknown
- Choose (a), 209 as being "estimated from measured data." (This value is the second most conservative.)

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CAS NUMBER	NAME	Vapor Pressure (mmHg)	Ref.	Henry's Constant (atm-m³/M)	Ref.	Hydrolysis Rate Constant (k_a,k_b,k_n)	Ref.
67-66-3	Chloroform	151	8^b	3.40×10^{-3} @ $25C^{1.16}$	7^b	k_b=0.23 @ $25C^{1.6}$	13^b
		100 @ 10.4C	5^b	3.19×10^{-3} @ 25C	11^b	$k_a=0^{\ 1.8}$	13^c
		160 @ 20C	1^a	2.88×10^{-3} @ $20C^{1.11}$	13^b	$k_n=3\times10^{-9}\ ^{1.9}$	17^a
		245 @ 30C	1^a	3.58×10^{-3} @ 25C	7^b	$k_n=2.5\times10^{-9}\ ^{1.7}$	13^b
		150.5 @ 20C	42^a			$k=2.96\times10^{-8}\ ^{1.4}$	10^b
		194.8 @ 25C	2^a				
71-43-2	Benzene	95.2 @ 20-30C	8^b	$5.55x-10^{-3}$@$25C^{2.36}$	7^b	NHFG $^{2.31}$	13^a
		60 @ 15C	1^a	$5.49\times10^{-3}\ ^{2.28}$	29^b	NHFG $^{2.32}$	17^a
		76 @ 20C	1^a	$5.55\times10^{-3}\ ^{2.29}$	29^a		
		100 @ 26.1C	5^a	0.227	20^a		
		95.19 @ 25C $^{2.22}$	27^a	5.5×10^{-3}@25C $^{2.37}$	13^d		
		182.86 @ 40C $^{2.23}$	27^a				
		95 @ 25C $^{2.27}$	29^b				
		74 @ 20C $^{2.26}$	28^b				
		95 @ 25C	19^a				
		118 @ 30C	1^a				
118-16-4	Hexachlorobenzene	1.09×10^{-5}	8^b	1.70×10^{-3} @ 25C	7^b	HMES $^{3.24}$	13^c
		1.9×10^{-5} @ 25C	19^a	0.03-0.07 @ 20C	12^b		
		0.420×10^{-5} @ 15C $^{3.17}$	9^b	0.07	20^a		
		0.581×10^{-5} @ 15C $^{3.18}$	9^b	6.8×10^{-4} @25C $^{3.23}$	13^d		
		1.73×10^{-5} @ 25C $^{3.17}$	9^b	-----$^{3.12}$	47^a		
		2.10×10^{-5} @ 25C $^{3.18}$	9^b				
		6.48×10^{-5} @ 35C $^{3.17}$	9^b				
		6.97×10^{-5} @ 35C $^{3.18}$	9^b				
		22.4×10^{-5} @ 45C $^{3.17}$	9^b				
		21.5×10^{-5} @ 45C $^{3.18}$	9^b				
		$0.396\pm0.024\times10^{-5}$@$15C^{3.19}$	9^a				
		$1.91\pm0.20\times10^{-5}$@$25C^{3.19}$	9^a				
		$6.40\pm0.32\times10^{-5}$@$35C^{3.19}$	9^a				
		$20.9\pm8.89\times10^{-5}$@$45C^{3.19}$	9^a				
127-18-4	Tetrachloroethylene	17.8	8^b	2.59×10^{-2}	8^d	$k_a=k_b=k_n=0\ ^{4.10}$	13^c
		18.47 @ 25C	2^b	2.87x10-2	7^b	-----NR $^{4.12}$	36^c
		20 @ 25C	19^a	$2\times10^{-2}\ ^{4.14}$	36^a		
		14 @ 20C	42^a	1.174	20^a		
				0.0153	13^a		

KEY

a = experimentally measured value
b = estimated by extrapolation or interpolation from measured data
c = estimated using molecular structure
d = estimated from values which were themselves estimated
e = unknown data type

NOTE: Values for which the primary reference has not been checked are designated as 'b'.

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DW List Parameter _. aft Copy

CAS NUMBER	NAME	Vapor Pressure (mmHg)	Ref.	Henry's Constant (atm-m³/M)	Ref.	Hydrolysis Rate Constant (k_a,k_n,k_b)	Ref.
121-14-2	2,4-Dinitrotoluene	$5.10x10^{-3}$ @ 20C	13^a	$4.07x10^{-6}$ @ $25C^{a.4}$	7^b	$HNES^{a.2}$	13^c
		$1.3x10^{-3}$ @ 59C	16^a	$1x10^{-8}$ to $1x10^{-6}$	10^a		
		$7.6x10^{-5}$ @ 25C	19^a	$5.09x10^{-6}$ $20\text{-}30C^{a.1}$	6^a		
		$1.23x10^{-5}$ @ 4C	15^a				
		$2.85x10^{-5}$ @ 10C	15^a				
		$1.32x10^{-4}$ @ 20C	15^a				
7440-38-2	Arsenic and Compounds						
1303-28-2	Arsenious $Acid^{6.1,6.7}$ (H_3AsO_3)	----- $-----^{6.3}$		$-----^{6.6}$		$-----^{6.6}$	
1327-53-3	Arsenic $Acid^{7.1}$ (H_3AsO_4)	$-----^{7.4}$		$-----^{7.8}$		-----	
7440-41-7	Beryllium [$Be(OH)_2$]	-----		-----		-----	
14797-55-8	Nitrates $NaNo_3$ KNO_3	----- -----		----- -----		----- -----	6^a
14797-65-8	Nitrites $NaNo_2$ KNO_2	----- -----		----- -----		----- -----	

a = experimentally measured value
b = estimated by extrapolation or interpolation from measured data
c = estimated using molecular structure
d = estimated from values which were themselves estimated
e = unknown data type

NOTE: Values for which the primary reference has not been checked are designated as 'b'.

JW List Parameters _ .t Copy

CAS NUMBER	NAME	Octanol/Water Partition Coefficient (log K_{ow})	Ref.	Organic Carbon Coefficient (K_{oc})	Ref.	Solubility (mg/L)	Ref.	Activity Coefficient	Ref.
67-66-3	Chloroform	1.97	8^b	31 $^{1.13}$	8^b	$8.20x10^3$ @ 20-30C	8^b	-----	
		1.95 $^{1.3}$	13^a	34	14^b	6000 @ 20C	1^a		
		1.97	10^b	44 $^{1.2}$	13^a	9300 @ 25C	1^a		
						8200 @ 20C	42^a		
						10000 @ 15C	1^a		
71-43-2	benzene	2.12	8^b	83	8^b	$1.75x10^3$	8^b	$2.3x10^3$ $^{2.20}$	27^a
		2.13	1^a	920 $^{2.6}$	23^a	1780 @ 20C	1^a	$2.2x10^3$ $^{2.21}$	27^a
		2.13 $^{2.1}$	21^a	$2.78x10^1$	19^a	820 $^{2.6}$	23^a		
		2.25 $^{2.2}$	21^a	65$^{2.34}$	13^a	1780 $^{2.26}$	29^a		
		2.13 $^{2.7}$	24^a			1000	20^a		
		2.32	20^a			$8.2x10^2$ @ 25C	19^a		
		2.13 $^{2.30}$	19^a						
118-18-4	Hexachlorobenzene	5.23	8^b	3900	8^b	$6.0x10^{-3}$	8^b	$9.77x10^8$ $^{3.21}$	7^a
		6.2	1^a	10^4-10^5	16^b	0.11 @ 24C	1^a		
		5.2	20^a	0.00175	20^a	$6x10^{-3}$ @ 25C	19^a		
		8.0	19^a	$3.954x10^8$	19^a	$6.6x10^{-3}$ $^{3.6}$	47^b		
		6.915 $^{3.2}$	13^a	$1.2x10^6$ $^{3.1}$	13^a	$6.2x10^{-3}$ @ 23.5C $^{3.20}$	9^a		
		6.18	24^a			$2.12x10^{-3}$	16^a		
127-18-4	Tetrachloroethylene	2.6	8^b	209 $^{4.6}$	34^b	$1.50x10^2$	8^b	-----	
		2.88	10^b	229 $^{4.7}$	34^a	150-200 @ 20C	10^b		
		2.60 $^{4.9}$	4^b	245 $^{4.8}$	34^a	241.8	20^a		
		2.6	20^a	$3.5x10^{-4}$ $^{4.13}$	36^a	$1.5x10^2$ @ 25C	19^a		
		3.1	19^a	166	19^a				
		2.9	13^a	364$^{4.20}$	13^a				
121-14-2	2,4-Dinitrotoluene	2	8^b	45 $^{5.6}$	13^a	$2.40x10^2$	8^b	-----	
		2.01 $^{5.5}$	10^a	$1.072x10^2$	19^a	270 @ 22C	10^b		
		3.14	19^a			$3x10^2$ @ 25C	19^a		
7440-38-2	Arsenic and Compounds								
1303-28-2	Arsenious Acid$^{6.1}$,$^{6.7}$ (H_3AsO_3)	-----$^{6.6}$		-----$^{6.6}$		$3.70x10^4$ @ 20C -----$^{6.2}$	6^b	-----$^{6.6}$	
1327-53-3	Arsenic Acid$^{7.1}$ (H_3AsO_4)	-----		-----		$1.5x10^6$ @ 16C $^{7.8}$ -----$^{7.9}$ -----$^{7.2}$	6^b 46^b	-----	

OW List Parameters Draft Copy

CAS NUMBER	NAME	Octanol/Water Partition Coefficient (log K_{ow})	Ref.	Organic Carbon Coefficient (K_{oc})	Ref.	Solubility (mg/L)	Ref.	Activity Coefficient	Ref.
7440-41-7	Beryllium [$Be(OH)_2$]	-----		-----		-----			
14797-55-8	Nitrates					-----?.?			
	$NaNO_3$	-----		-----				-----	
	KNO_3	-----		-----		9.21×10^{5} @ 25C	5*		
						1.33×10^{5} @ 0C	6*		
14797-65-8	Nitrites								
	$NaNO_2$	1.39	19*	1.67×10^{-1}	19*	8.15×10^{5} @ 15C	5*	-----	
						8.15×10^{5} @ 25C	19*		
	KNO_2	-----		-----		2.81×10^{5} @ 0C	6*		

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CAS NUMBER	NAME	Viscosity (cp)	Ref.	Density (g/cm^3)	Ref.	Log Equilibrium Constant (pK$_a$,pK$_b$)	Ref.	Photolysis Rate Constant k$_p$ (hr^{-1})	Ref.
67-66-3	Chloroform	0.596 @ 15C	2^{a}	1.489 @ 20C$^{1.14}$	1^{a}	NER $^{1.12}$	13^{c}	PNER $^{1.13}$	13^{c}
		0.514 @ 30C	2^{a}	1.49895 @ 15C	5^{a}				
		0.529 $^{1.1}$ @ 25C	43^{b}	1.4832 @ 20C$^{1.10}$	6^{a}				
71-43-2	Benzene	0.6487 @ 20C	2^{a}	0.8786 @ 20C$^{2.33}$	1^{a}	-----		-----	
		0.6028 @ 25C	2^{a}	0.8794 @ 20C	5^{a}				
		0.5621 @ 30C	2^{a}	0.8791 $^{2.7}$	22^{a}				
		0.65001 @ 20C$^{2.3}$	22^{a}	0.8737 $^{2.8}$	22^{a}				
		0.64983 @ 20C$^{2.4}$	22^{a}	0.877	19^{a}				
		0.60345		0.8765 @ 20C	6^{a}				
		0.595$^{2.33}$ @ 25C	43^{b}						
118-18-4	Hexachlorobenzene	-----		2.044 @ 23C	4^{a}	-----		0.000014 $^{3.7}$	47^{a}
				1.57	5^{a}			0.00066 $^{3.11}$	47^{a}
				2.044	19^{a}			-----$^{3.10}$	47a^{e}
				1.5691	6^{a}			-----$^{3.4}$	48^{a}
								-----$^{3.5}$	48^{a}
127-18-4	Tetrachloroethylene	0.932 @ 15C	2^{a}	1.6227 @ 20C	6^{a}	-----		0.57 min^{-1} $^{4.3}$	32^{a}
		0.798 @ 30C	2^{a}	1.6311 @ 15C	3^{a}			0.078 min^{-1} $^{4.4}$	32^{a}
		0.84$^{4.19}$ @ 20C	43^{a}	1.623 @ 25C	19^{a}			-----$^{4.11}$	35^{a,b}
								-----$^{4.17}$	36^{c}
121-14-2	2,4-Dinitrotoluene	-----		1.3208 @ 71C	6^{a}	-----		1.6x10^{-2} $^{5.3}$	13^{a}
				1.320	19^{a}				
7440-38-2	Arsenic and Compounds								
1303-28-2	Arsenious Acid$^{6.1}$,$^{6.7}$ (H$_3$AsO$_3$)	-----$^{6.4}$		7.738 $^{6.3}$	6^{a}	pK$_1$ 5.9x10^{-10} @ 25C $^{6.8}$	6^{a}	-----$^{6.6}$	
				-----$^{6.5}$		pK$_2$ 9.23 @ 25C^{1} $^{6.9}$	6^{a}		
						pK$_3$ 12.13 @ 25C $^{6.12}$	46^{b}		
						pK$_3$ 12.71 @ 25C $^{6.10}$	46^{b}		
						pK$_2$ 9.29 $^{6.11}$	46^{b}		
						pK$_2$ 9.294	18^{a}		

DW List Parameters Draft Copy

CAS NUMBER	NAME	Viscosity (cp)	Ref.	Density (g/cm^3)	Ref.	Log Equilibrium Constant (pK_a, pK_b)	Ref.	Photolysis Rate Constant $k_p (hr^{-1})$	Ref.
1327-53-3	Arsenic Acid$^{7.1}$ (H_3AsO_4)	-----		4.32	6^a	pK_1 2.3 @ 25C^{2} $^{7.6}$	6^a	-----	
						pK_2 6.8 @ 25C^{3} $^{7.7}$	6^a		
						pK_3 11.5 @ 25C^{4}	6^a		
						pK_1 2.24 25C $^{7.6}$	46^a		
						pK_2 6.94 25C $^{7.7}$	46^a		
						pK_3 11.50 25C $^{7.6}$	46^a		
						pK^1 2.19	18^a		
						pK_2 6.94	18^a		
						pK_3 11.50	18^a		
7440-41-7	Beryllium $[Be(OH)_2]$	-----		1.92	3^a	pK_b = 11.3	6^a	-----	
14797-55-8	Nitrates							$3.3x10^{-8}S^{-1}$ $^{9.6}$	37^a
								-----$^{9.7}$	37^a
								-----$^{9.10}$	39^a
								~$10^4M^{-1}sec^{-1}$ $^{9.11}$	40^a
								-----$^{9.12}$	40^a
	$NaNO_3$	-----		2.261	5^a	-----		0.04106sec^{-1} $^{9.8}$	38^a
	KNO_3	-----		2.109 @ 16C	5^a	-----		0.0608sec^{-1} $^{9.9}$	38^a
14797-65-8	Nitrites								
	$NaNO_2$	-----		2.168	5^a	-----		-----	
				2.170	19^a				
	KNO_2	-----		1.915	5^a	-----			

OW List Parameters D... Copy

CAS NUMBER	NAME	BIODEGRADATION RATE CONSTANT (AEROBIC)	REF	BIODEGRADATION RATE CONSTANT (ANAEROBIC)	REF	MOLECULAR DIFFUSIVITY (-------)	REF	SORPTION COEFFICIENT (K_d) (------------)	REF
67-66-3	Chloroform	-----		-----		0.0888$^{1.3}$ @ 25C	44^{b}	-----	
71-43-2	Benzene	-----$^{2.8}$	25^{a}	-----		0.0932$^{2.20}$ @ 25C	44^{b}	-----$^{2.15}$	26^{a}
		-----$^{2.9}$	25^{a}					2.4 $^{2.16}$	26^{a}
		-----$^{2.10}$	25^{a}					1.8 $^{2.17}$	26^{a}
		-----$^{2.11}$	25^{a}					30.9 $^{2.18}$	26^{a}
		-----$^{2.12}$	25^{a}					4.4 $^{2.19}$	26^{a}
		-----$^{2.13}$	25^{a}						
		-----$^{2.14}$	25^{a}						
		-----$^{2.15}$	25^{a}						
118-18-4	Hexachlorobenzene	-----		-----		0.059$^{3.3}$ @ 25C	45^{c}	2627 $^{3.9}$	47^{a}
						1.0x10^{6}cm^{2}/day $^{3.16}$	9^{a}	-----$^{3.8}$	47^{a}
								4.193 $^{3.13}$ ng/g	16^{a}
								276 $^{3.14}$ ng/g	16^{a}
								136 $^{3.15}$ ng/g	16^{a}
127-18-4	Tetrachloroethylene	-----$^{4.2}$	31^{a}	-----NAD $^{4.1}$	30^{a}	D^{*}_{1}/D^{*}_{1}=0.5 $^{4.15}$	36^{a}	0.56±0.09 $^{4.15}$	34^{a}
		-----$^{4.3}$	33^{a}			D^{*}_{e}/D^{-}_{e}=0.36 $^{4.16}$	36^{a}		
		-----NAD $^{4.1}$	30^{a}			0.0797$^{4.21}$ @ 25C	45^{a}		
121-14-2	2,4-Dinitrotoluene	-----		-----		-----		-----	
7440-38-2	Arsenic and Compounds								
1303-28-2	Aresnious Acid$^{6.1}$,$^{6.7}$ (H_3AsO_3)	-----$^{6.6}$		-----$^{6.6}$		-----$^{6.6}$		-----$^{6.6}$	
1327-53-3	Arsenic Acid$^{7.1}$ (H_3AsO_4)	-----$^{7.3}$		-----$^{7.3}$		-----		-----	
7440-41-7	Beryllium [Be(OH)$_2$]	-----		-----		-----		-----	

GW List Parameters t Copy

CAS NUMBER	NAME	BIODEGRADATION RATE CONSTANT (AEROBIC)	REF	BIODEGRADATION RATE CONSTANT (ANAEROBIC)	REF	MOLECULAR DIFFUSIVITY (-------)	REF	SORPTION COEFFICIENT (K_d) (------------)	REF
14797-55-8	Nitrates	-----[9.2]	41*	-----[9.2]	41*	$10^{-6}cm^2s^{-1}$ [9.3]		41*	
	$NaNo_3$			$13.6x10^{-6}s^{-1}$ [9.13]	41*	$1.8x10^{5}cm^2s^{-1}$ [9.4]		41*	
	KNO^3			$15.6x10^{-6}s^{-1}$ [9.14]	41*				
				$1.9x10^{-6}s^{-1}$ [9.15]	41*				
				$3.2x10^{-6}s^{-1}$ [9.16]	41*				
				$13.2x10^{-6}s^{-1}$ [9.17]	41*				
				$9.5x10^{-6}s^{-1}$ [9.18]	41*				
				$4.7x10^{-6}$ [9.19]	41*				
				$4.5x10^{-6}$ [9.20]	41*				
				$0.8x10^{-6}s^{-1}$ [9.21]	41*				
				$0.6x10^{-6}s^{-1}$ [9.22]	41*				
				$0.5x10^{-6}s^{-1}$ [9.23]	41*				
				$0.6x10^{-6}s^{-1}$ [9.24]	41*				
				$1.0x10^{-6}$ [9.25]	41*				
				$0.8x10^{-6}$ [9.26]	41*				
				$1.0x10^{-6}$ [9.27]	41*				
				$1.9x10^{-6}$ [9.28]	41*				
				$0.5x10^{-6}$ [9.29]	41*				
				$1.3x10^{-6}$ [9.30]	41*				
				$1.2x10^{-6}$ [9.31]	41*				
				$2.9x10^{-6}$ [9.32]	41*				
				$2.7x10^{-6}$ [9.33]	41*				
				$8.8x10^{-6}$ [9.34]	41*				
14797-65-8	Nitrites	-----		-----		-----		-----	
	$NaNo_2$								
	KNO_2								

1.1 Viscosity unit is "mPa-s"

1.2 Value of Koc was calculated from the Kow value using the equation Koc=0.48Kow.

1.3 Value of Kow was obtained by computer calculation, using FRAGMENT calculation procedure.

1.4 In hr-1. Estimated for pH7 and 25C from data (Radding, et al.) extrapolated from 100-150C. Corresponds to "a first order rate constant for hydrolysis of 6.9 x 10-12 sec -1". The "validity of the extrapolation method has not been established". This value is "in sharp contrast" to the first-order rate constant of 0.045 month-1 (Dillinger, et.al.) reflecting a "primarily ionic" mechanism. Discrepancies exist for other halomethanes.

1.5 Diffusivity in air in cm2 s-1

1.6 In M-1 hr-1.

1.7 In hr-1; at 25C.

1.8 ka=0 "No acid catalyzed mechanism".

1.9 In hr-1.

1.10 Specific gravity; relative to water at 4X.

1.11 Calculated from vapor pressure and solubility at 20C.

1.12 NER = pK "not environmentally relevant".

1.13 PNER = "photolysis not environmentally relevant".

1.14 Specific gravity.

1.15 Koc in ml/g.

1.16 Level or confidence = error= greater then one order of magnitude (Note: this reference contains many values for Hc; all approximately the same value).

2.1 Observed [from A. Leo, Hansch, and Elkins; Chem Rev 71,525(1971) and C. Hansch and A. Leo "Substituent Constants for Correlation Analysis in Chemistry and Biology" John Wiley & Sons, N.Y., 1979]

2.2 Log Kow calculated as function of solubility.

2.3 Experimentally determined from Kinematic viscosity at 20C 99.7% pure, v=0.73952mm2/s and desnity d=0.8791 g/cm3.

2.4 Expermentally determined from Kinematic viscosity at 20C, 99% pc v=0.73920mm2/s, and d as in footnote 2.3.

2.5 Expermentally determined from kinematic viscosity v=0.69068 at 25C, 99.7% pure, density d=0.8737.

2.6 Aqueous solubility; determined on estvarine colloids; organic carbon = 42.0mg/l.

2.7 Associated with value for Kp, correlated experimentally with GLC retention time.

2.8 100% degradation; benzene at 5ug/L; third subculture; representing biota of domestic sewer sludge. 1st subculture 49% biodegradation.

2.9 66% removal; biological treatment system; 8.8ug/L influent level; by municipal activated sludge.

2.10 92% removal: 7.7 ug/L influent level; municipal activated sludge.

2.11 90-100% removal; industrial activated sludge.

2.12 96% removal; aerated lagoon; 6.53ug/L influent level.

2.13 99% removed; 160ug/L influent level; activated sludge with powdered activated carbon added.

2.14 >60% removed; 10,250ug/L influent level. Industrial activated sludge.

2.15 >84% removed; 46.9ug/L influent level; Industrial activated sludge.

2.16 Kd=2.4, Hasting silty clay loam.

2.17 Kd=1.8 Overton silty clay loam.

2.18 Kd=3.09 Al-saturated montmorillinite.

2.19 Kd=4.4 Ca-saturated montmorillonite.

2.20 At 25C; corresponds with vapor pressure value of 95.19mmHg. Concentrations in water at equilibrium with threshold value = 0.15mg/L.

2.21 At 40C; corresponds with vapor pressure of 182.86mmHg. Concentration in water at equilibrium with threshold value = 0.08mg/L.

2.22 At 25C; see footnote 2.20.

2.23 At 40C; see footnot 2.21.

2.24 Saturation vapor pressure; determined in conjunction with Kd (see footnote 2.25).

2.25 At 23.8C Uptake of benzene vapors by dry woodburn 0 relative humidty soil: ~30mg/g at P/P =1; 13mg/g at P/P =0.85; ~11mg/g at P/P =0.8; ~7.5mg/g at P/P =0.35.

At 20C uptake at 50% relative humidity; ~8mg/g at P/P =0.6; ~5mg/g at P/P =0.4; (linear relationship).

At 90% relative humidity ~4mg/g at P/P =0.8; ~2mg/g at P/P =0.5.

P/P = relative vapor concentration; P = equilibrium partial pressure; DO = saturation vapor pressure.

2.26 At 25C [given as 1,789gm-3]
from McAuliff C., J. Phys Chem 70, 1267(1966)

2.27 From Zwolinski, Wilhoit, "Handbook of Vapor pressures and Heats of Vaoporization of Hydrocarbons and Related Compounds" AP1, 44-TRC- Publ. in Sci and Eng., 1971.

2.28 Calculated from measured values.

2.29 Experimentally determined.

2.30 Diffusivity in air.

2.31 Hydrolysis not significant.

2.32 NHFG = "No hydrolyzable functional group".

2.33 Viscosity unit is "mPa-s"

2.34. Value of Koc was calculated from the Kow value (135), using the equation Koc=0.48Kow. (See footnote 2.38.)

2.35 Specific gravity; relative to water at 4C.

2.36 Error (level of confidence) = ± 30%.

2.37 Calculated from vapor pressure and solubility at 25C.

2.38 Calculated by computer calculation (FRAGMENT).

3.1 Value of koc was calculated from the kow value using the equation koc=0.48kow.

3.2 Value of kow was obtained by computer calculation, using FRAGMENT calculation procedure.

3.3 Diffusivity in air calculated using F,S and G method (Lyman, 1982).

3.4 Photolysis of solid hexachlorobenzene on silica gel "extremely slow":. Sample irradiated for 4.5h in sunlight "extremely small amounts of photoproducts". Crystalline hexachlorobenzene exposed

5 months to "sun lamp or laboratory illumination" had no detectable photoproducts as determined by (by GLC or HPLC).

3.5 After 15 days irradiation in sunlight; 38% recovered from hexachlorobenzene in methanol.

3.6 From Callahan Slimak, and Gabel, et al. Water Related Environmental Fate of 129 Priority Pollutants. EPA 440/4-79-0296, US EPA; Washington, DC. (ref 13)

3.7 Calculated from experimental data and from impirical relationship; Kp for pure water (see footnote 3.10).

3.8 Ksorp = rate constant for sorption by sediment (0.13mL/cm2hr).
kdesorp = rate constnt for desorption from sediment; 0.00067 hr-1.

3.9 Experimentally determined; pond sediment

3.10 Quantum yeild = 0.00603 at 313nm in distilled water.

3.11 Photolysis rate constant calculated for 40 north latitude at noon in the fall, in hr-1.

3.12 Volatization rate constant 2.76 cm/hr.

3.13 Soil: Houghton Mock (16.81% organic carbon). Freundlich, K; units ng/g. Experimental absorption of C-hexachlorobenzene by soils from aqueous solution. Data plotted according to Freundlich adsorption equation (from a Adamson, 1967) x/m=KC-n. x = ug (or ng) of compound sorbed. m = weight of adsorbent in g. c = equilibrium concentration of solution (in (ug or ng/l).

3.14 Catlin silt loam; 4.73% organic carbon; 1/2 = 0.99 (see footnote 3.13).

3.15 Ava silty clay loam; 1.18% organic carbon; 1/n = 0.93 (see footnote 3.13).

3.16 Do = vapor diffuision coefficient in air (in cm2/day). Experimentally determined utilizing Fick's first law: J=Ds(c2-Cs)/L and equation (developed from Millington and Quirk, 1961)
Ds=Ds(pa10/3/Pt2)
where J = vapor flux through soil (in ug cm-2 day-1);
Ds = apparent steady-state diffusion coeffient (in cm2/day);
Cs = concentration or vapor density of volatile substance in air at soil surface (in mg/liter);
C2 = concentration in air at bottom of soil layer (in mg/liter);
L = soil depth (in cm), Pa = soil air-filled porosity (in cm3/cm3); and Pt = total soil porosity (in cm3/cm3).

3.17 Vapor pressure calculated from log p=12.94-(5279/T).

3.18 Literature values "extrapolated from the data of Sears and Hopke (1949).

3.19 Experimentally determined; calculated from vapor density (wt/vol) by $p = (wt/vol)\ (RT/M)$.

3.20 From unpublished data M. Yang and W.J. Farmer.

3.21 At infinite dilution.

3.22 Solubility 2.22 ppb in creek water (C. Griffin and Chou, 1980).

3.23 Henry's law constant calculated from vapor pressure and solubility at 25C.

3.24 HNES = "Hydrolysis not significant".

4.1 N.A.D "No Appreciable Degradation" in aerobic or anaerobic condition.

4.2 No observable biodegration.

4.3 Photolysis in purified water. The rate of substrate disappearance is represented by the linear combination of four contributing processes; purging, photolysis ozonization, and photolytic oxidation. Data refers to photolysis process only.

4.4 In lake water. See footnote 4.3.

4.5 No degradation observed in live or dead culture.

4.6 From Chiou, Peters, Freed; Science 1979,206,831.

4.7 From $\log Koc = 0.72 \log Kow + 0.49$.

4.8 From $\log Koc = 1.00 \log Kow - 0.21$ (Karichkhoff, Brown, Scott, Water Res 1979,13,241).

4.9 From Chiou, Schmeddling, Kohnert, Env. Sci. Tech. 1977,11,475.

4.10 From average of six measurement b (extropoloted) from measured.

4.11 Measured half-lives (t1/2): 14.2h for tetrachloroethylene at 10 ppm, no 5ppm; 1 atm, 27±1c, 9.58L UV cutoff 290nm; I=2.6x natural sunlight/noon (summer (Texas)) 35-409 relative humidity (94 ulH_2O)

a/measured t.44 = 12.5 hr; same conditions;

b extrapdated t1/2 :83hr $CCl_2=CCl_2$ 10ppm; NO_2 16.8 ppm from measured

a meas t.42 7.0hr; as above

b extrap from meas t1/2 :11.2hr $CCl_2=CCl_2$ 10ppm; 5ppm NO

a meas t.29 6.5hr; as above

a meas t1/2 7.0hr $CCl_2=CCl_2$=40ppm NO; 20ppm

a meas t1/2 3.8hr $CCl_2=CCl_2$=100ppm NO; 50ppm

4.12 Hydrolysis "not relevant"

4.13 Calculated from Kow f(oc)(s) Koc = Kp(s)xbx(Kow)a in units of m3 m3 g-1 oc (not a dimensionless ratio).

4.14 Calculated; empirical relationship.

4.15 Calculated ratio of molecular diffusivity of perchloroethylene in aqueous solution to diffusivity of oxygen in aqueous solution. Dimensionless, individual diffusivity terms in area (m2) per time (hr).

4.16 Calucated ratio of molecular diffusivity of perchloroethylene in air to that of water in air from Dzg/Dwg=85(1/m2+0.0347)1/2x((EV2)1/3+2.72)1/2

4.17 Photolysis not relevant.

4.18 Hydrolysis rate is not environmentally significant.

4.19 Vicosity unit is "mPa-s".

4.20 Value of Koc was calculated from the Kow value using the equation Koc=0.48Kow.

4.21 Diffusivity in air calculated using F,S and G method (Lyman, 1982).

5.1 Henry's law constant calculated by (Vapor Pressure) (MW)/(Solubility).

5.2 HNES - "Hydrolysis not environmentally significant".

5.3 Photolysis rate constant calculated for summer at 40 latitude.

5.4 Henry's law constant calculated from vapor pressure and solubiity. Level of confidence (error) ±1 order of magnitude.

5.5 Calculated by the method Tute 1971.

5.6 Calculated from Koc = 0.48 Kow.

6.1 Arsenious acid; the acid that corresponds to arsenite salts. Does not exist in solid, free state; exists in solution as arsenite anion.

Arsenious acid is Oxyanion of Arsenic III; subject to oxidation reactions (i.e. reducing agent) yeilding AsIV (arsenate).

Predominant species in reduced conditions; unstable in oxidized conditions where eV=0.

Various formulas exist for the acid (which is hypothetical entity); H3AsO3 or HAsO2. Usually considered indentical; but data exists differentiating between the two (see reference 46).

6.2 Water solubility of arsenious acid is not applicable, since solid arsenious acid does not exist outside of solution. Solubility is defined for arsenite anions as specific salts.

6.3 Vapor pressure of Arsenious acid not applicable since solid compound does not exist in free state.

6.4 Viscosity for this parameter is not applicable since it is not a fluid.

6.5 Density - this parameter not applicable to arsenious acid; since pure compound does not exist. Paramter is relevant for; compounds of arsenious acid (ex: salts), and solutions of orgenites (arsenous acid salts).

6.6 Values for this parameter are applicable only to a stable solution containing arsenite anion. The solution species that exists is a funciton of pH and electrochemical potential (eV).

6.7 The following equations describe the oxidation-reduction of [(arsenious acid/arsenites) and oxides]. [These equilibria are related to pKa.] K calculated by

6.8 For H3AsO3<--->H2AsO3- +H+

6.9 For H2AsO3--->HAsO3-2 +H+

6.10 For HAsO32--->AsO3-3 +H+

6.11 For HAsO2-->AsO2- +H+

6.12 For H2AsO3--->HAsOss- +H+

7.1 Arsenic Acid. Arsenic acid exists as H3AsO4 only in pure solid phase. Arsenic acid in natural ground water systems exists as a solution that is dissociated to an extent controled by pH. In solution H3AsO4, H2AsO4-2, HAsO4-3, and AsO4-3 occur. H3AsO4 exists as main species in acidic environment (pH<pKa), AsO42 exists as main species in alkaline environment. At pH 4-9, HAsO4-2 and H2AsO4- predominate.

Arsenic acid is a special case of arsenate, (i.e. "hydrogen arsenate"). In any natural environmental situation, the species that exists are arsenates of metal cations. Arsenic acid (arsenates) are also formed by dissolution of arsenic troioxide and pentoxide (As2O3 and As2O5); and oxidation-reduction reactions of arsenites (arsenious acid).

7.2 The solubility of arsenates is controlled by the metal ions present. Any dissolved arsenic acid species will precipitate out of solution when dissolved metals are present. and arsenotes will redissolve when the concentration of metal cations in the aqueous environment is less than the concentration of metal cations in the solubility product constant (Ksp).

Arsenic acid is formed from dissolved As2O5 in water or As2O3 (depending on pH, eV).

Arsenic acid (arsenate) is interconvertable to arsenite by reduction. Wide application of this redox (AsIII+2e-->AsV) is employed in chemistry. The lower valence states of many metals, inorganic anions, etc., participate in redox reactions; i.e. Fe+2; Cu+1; Cr+3, etc.

7.3 Arsenic acid is subject reduction by biodegradation to arsine (AsH3), a volatile gas, and to methyl and dimethyl arsine.

7.4 Does not exist in gaseous state "2H3AsO4-->3H2O + As2O5"

7.5 Not applicable; a solid.

7.6 Calucalted for H3AsO4-->H2AsO4- +H+

7.7 For H2AsO4-->HAsO4-2+H+

7.8 For HAsO4-2-->AsO4-3+H+

7.9 The following equations describe the solubility of arsenic acid (arsenate) with cations in solution (see footnote 6.8). K = Ksp solubility is a function of pH.

$AsS(realger) + 8H_2O = HAsO_4^{2-} + SO_4^{2-} + 11\bar{e} + 15H^+$	-83.13
$As_2S_2(Orpiment)16H_2O = 2HAsO_4^{2-} + 2SO_4^{2-} + 22\bar{e} + 23H^+$	-180.42
$As_2S_3(c) + 20H_2O = 2HAO_4^{2-} + 3SO_4^{2-} + 30\bar{e} + 38H^+$	-219.14
$AlAsO_4(c) + H^+ = A^{3+} + HAsO_4^{2-}$	-4.70
$Ca_3(AsO_4)_2(c) + 2H^+ = 3Ca^{2+} + 2HAsO_4^{2-}$	-1.91
$Cd_3(AsO_4)_2(c) + 2H^+ = 3Cd^{2+} + 2HAsO_4^{2-}$	-8.97
$Cu_3(AsO_4)_2(c) + 2H^+ = 3Cu^{2+} + 2HAsO_4^{2-}$	-14.97
$FeAsO_4(c) + H^+ = Fe^{3+} + HAsO_4^{2-}$	-8.59
$Mn_3(AsO_4)_2(c) + 2H^+ = 3Mn_n^{2+} + 2HAsO_4^{2-}$	-8.51
$Ni_3(AsO_4)_2(c) + 2H^+ = 3Ni^{2+} + 2HAsO_4^{2-}$	-2.21
$Pb_3(AsO_4)_2(c) + 2H^+ = 3Pb^{2+} + 2HAsO_4^{2-}$	-9.07
$Zn_3(AsO_4)_2(c) + 2H^+ = 3Zn^{2+} + 2HAsO_4^{2-}$	-8.20

The following reaction describes the solubility of arsenic pentoxide in water to form argenic acid.

7.10 The following equations describe the oxidation-reduction reactions of Arsenite-Arsenate (Arsenious acid-Arsenic Acid). (See footnote 7.8.) These values describe the relationship of the equalifbrium constant (acid dissociation constant and oxidation-reduction.

9.1 Nitrates (NO3) do not exist as stable species per se, but as the anionic portion of a solid; crystalline ionic species, occuring with a cation, forming a neutral molecule. (The ionic character of these crystals exists in degrees depending on the metal.) It is in the form that nitrates enters the environment - as dissolved salts (or less frequently, from dissolved nitrogen oxides).

Nitrogen oxides dissolved in water form nitric acid (nitrates), nitrous acid (nitrites, etc. The many varieties of nitrogen oxides are in equilibrium with each other via oxidation-reduction, photolysis, evaporation, dissolution etc., in complex interrelationships that also include molecular nitrogen (N2) and ammonia (NH3). Nitrates dissolved in water in varying amounts depending on the cation-forming "free" nitrate anions. Nitric acid is special case of nitrates (hydrogen nitrate).

Nitrates and other species of nitrogen are involved in biodegradation/biotransformation.

9.2 Overall disappearance of nitrate by "biodegradation" = K = denitrification + reduction to ammonia. K = KD + KA. KA = rate constant for nitrate reduction, approximated as 1st order. KD = denitrification = 1 x 10-6 s-1. KA = 2 x 10-6 to 8 x 10-6; average 5 x 10-6.

9.3 Mass transfer coefficient; estimated 10-4cm2(s-1) (from Vanderborght).

9.4 Diffusion coefficient for nitrate in pure water 1.8x10-5cm2 s-1 (Handbook Chemistry and Physics. 1969).

9.5 Nitrates are salts of nitric acid; HNO3 [strong acid], ~ completely disociated "nitric acid" would be present in nitrate solutions from many processes including:

a) Hydrolysis of water by cation Mm+H2O M(m-1)+(OH-)m+H+

b) photolysis of NO3 yeilding nitrite and peroxynitrite

c) oxidation-reduction of nitrate and derivatives of nitrate

d) solutions-gas phase equilition of nitrogen oxides (N2O, NO, NO2, N2O3, N2O4, N2O5) anions and radicals

e) biodegradations.

9.6 kp1 for (see original article) formation of nitrates under NO2-+NO2-->NO3-+NO. P=0.40 torr; 2% NO2 in CO2. Wavelenghts 4131-5309A

Measured from slope of graph of values of photolysis of 2m1 Molar NO3- at 254nm alkaline (pH 12) solution: for reaction (NO3-)*--> NO2-+O (presented as rate of formation of nitrate per time.) Yield vares linearly with time. 8x(10)4x(NO2-yield)/mole=25x10-4time(sec): reaction inhibited by presence of added nitrate. NO2-

is not an inhibitor in alkaline photolysis, but absorbs energy.

9.7 kp2 for CO3-+NO2 NO3-+CO2 formation of nitrate same parameters as above.

Reaction in acidic solutions involves protonation of (NO3-)*; and self inhibated reaction.

In acidic solution; (pH2.8) 254nm, 293K, inadiated 3,600s; presence of NaASO2 increases quantum yield by factor of ~30, lessor degrees of increase observed for reaction in presence of stand, allyl alchol, and sodium bromide.

9.8 kp3 for NO3-+H2O+CO2 NO3-+H2O+CO2 formation of igomer of nitrate (probably OONO-) from nitrate same paramters as above.

Photolysis rate constant for crystalline NaNO3 at 203±5K P=3x10-7 Pa (1Torr=133.3Pa) radiation 1254cv (1.60x10-19 J=1ev)

9.9 Photolysis rate constant for crystalline KNO3. See footnot 9.7 for values of parameters.

9.10 Photolysis of sodium nitrate solutions (3.6.5 mole 1-1) at pH12 by UV light at 25C.

9.11 Photolysis rate of reaction of Ethanol with NO3 radical. C2HsOH+NO3 C2H3OH+NO2+H2O rate (for production of nitrite from nitrate) than without ethanol; at given pH value; "apparently due to the acceptor properties of ehtanol with respect to the NO3. (NO3 oxidized form of NO3-; nitrate).

9.12 Photocecomposition of nitrate to nitrite in alkaline solutions: in conditions of continuous irradiation NO3-, (excited anious) "remains constant and low", relative to nitrate ions.

9.13 Denitrification rate; 10C; 3-10cm depth; 10/5/22hr incubation time; location aressp; 77.

9.14 As in note 9.13, 46 hr incubation time.

9.15 as above; 24 hr incubation time (10/19/77)

9.16 as above; 46 hr incubation time.

9.17 as above 12C 0-3 cm depth; sampled 9/28/77 Norway 22 hr incubation time.

9.18 as above; 47 hr incubation time

9.19 as above, 3-10cm depth: 22hr incubation time.

9.20 as above; 47 hr incubation time.

9.21 3-10cm depth, initial NO3-N (Nitrate nitrogen) 0.8mgl-1 (sampled

5/17/71)

9.22 as above; NO3-N 4.8 mgl-1

9.23 3-10cm depth; NO3-N 1.2mgl-1 (6/1/77)

9.24 as above; NO3-N 7.2 mgl-1

9.25 3-10cm; NO3-N 8.1mgl-1; (6/29/77)

9.26 as above; NO3-N 8.1mgl-1

9.27 0-3cm depth; NO3-N 0.8mgl-1; (7/14/77)

9.28 as above; NO3-N 3.8mgl-1

9.29 3-10cm depth; NO3-N 0.5mgl-1

9.30 as above; NO3-N 2.4mgl-1

9.31 0-3cm; NO3-N 0.6mgl-1 (7/27/77)

9.32 as above; NO3-N 3.1 mgl-1

9.33 3-10cm; NO3-N 0.4mgl-1

9.34 as above, NO3-N 2.1mgl-1

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APPENDIX 4.4

INPUT DATA FOR GENERIC RUNS

GENERIC RUN 1
HYDROGEOLOGIC CATEGORY: 4
CHEMICAL: CHLOROFORM

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	—	0.0282	—	0.0226	0.0351
S	%	Exponential	—	0.295	—	0.1	1
B	m	Exponential	—	45	—	37	59
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.2	—	0.1	0.3
K_a	$\mathrm{mole}^{-1}\mathrm{hr}^{-1}$	—	0	—	—	—	—
K_b	$\mathrm{mole}^{-1}\mathrm{hr}^{-1}$	—	0.23	—	—	—	—
K_n	hr^{-1}	—	3×10^{-9}	—	—	—	—
K_{oc}	ml/g	—	31	—	—	—	—
"ADI"	mg/l	—	4.3×10^{-4}	—	—	—	—
Anaerobic biodegradation	S^{-1}	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: 0.05 $(\sqrt{A})$	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 1
HYDROGEOLOGIC CATEGORY: 4
CHEMICAL: CHLOROFORM

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 \ (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} \ (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	--	As defined by the CORR program

GENERIC RUN 2
HYDROGEOLOGIC CATEGORY: 4
CHEMICAL: HEXACHLOROBENZENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	—	0.0282	—	0.0226	0.0351
S	%	Exponential	—	0.295	—	0.1	1
B	m	Exponential	—	45	—	37	59
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.2	—	0.1	0.3
K_a	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_b	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_n	hr^{-1}	—	0	—	—	—	—
K_{oc}	ml/g	—	1.5×10^5	—	—	—	—
"ADI"	mg/l	—	2.1×10^{-5}	—	—	—	—
Anaerobic biodegradation	s^{-1}	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: $0.05 (\sqrt{A})$	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 2
HYDROGEOLOGIC CATEGORY: 4
CHEMICAL: Hexachlorobenzene

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	—	As defined by the CORR program

GENERIC RUN 3
HYDROGEOLOGIC CATEGORY: 4
CHEMICAL: TETRACHLOROETHYLENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	--	0.0282	—	0.0226	0.0351
S	%	Exponential	--	0.295	--	0.1	1
B	m	Exponential	--	45	—	37	59
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.2	—	0.1	0.3
K_a	$mole^{-1}hr^{-1}$	--	0	--	—	--	—
K_b	$mole^{-1}hr^{-1}$	--	0	—	—	—	—
K_n	hr^{-1}	--	0	—	—	--	—
K_{oc}	ml/g	--	209	—	—	—	--
"ADI"	mg/l	--	6.76×10^{-4}	--	—	—	—
Anaerobic degradation	s^{-1}	--	0	--	—	—	--
q	m/yr	Uniform	--	2	—	1	5.5
α_L under the source	m	Derived from A: 0.05 ($\sqrt{A}$)	—	—	—	—	--
α_L outside the source	m	Derived from X: 0.1 X	--	--	--	0	60

GENERIC RUN 3
HYDROGEOLOGIC CATEGORY: 4
CHEMICAL: TETRACHLOROETHYLENE

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	—	As defined by the CORR program

GENERIC RUN 4
HYDROGEOLOGIC CATEGORY: 4
CHEMICAL: BENZENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	—	0.0282	—	0.0226	0.0351
S	%	Exponential	—	0.295	—	0.1	1
B	m	Exponential	—	45	—	37	59
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.2	—	0.1	0.3
K_a	$mole^{-1}hr^{-1}$	—	0	—	—	—	—
K_b	$mole^{-1}hr^{-1}$	—	0	—	—	—	—
K_n	hr^{-1}	—	0	—	—	—	—
K_{oc}	ml/g	—	59	—	—	—	—
"ADI"	mg/l	—	6.63×10^{-4}	—	—	—	—
Anaerobic biodegradation	S^{-1}	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: 0.05 ($\sqrt{\hat{A}}$)	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 4
HYDROGEOLOGIC CATEGORY: 4
CHEMICAL: BENZENE

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	--	As defined by the CORR program

GENERIC RUN 5
HYDROGEOLOGIC CATEGORY: 4
CHEMICAL: 2,4 - DINITROTOLUENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	--	0.0282	--	0.0226	0.0351
S	%	Exponential	--	0.295	—	0.1	1
B	m	Exponential	--	45	—	37	59
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	--	0.2	—	0.1	0.3
K_a	$\text{mole}^{-1}\text{hr}^{-1}$	--	0	—	—	--	--
K_b	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_n	hr^{-1}	--	0	—	—	--	—
K_{oc}	ml/g	—	76	—	—	—	—
"ADI"	mg/l	--	1.13×10^{-4}	—	—	—	—
Anaerobic biodegradation	s^{-1}	--	0	—	—	—	—
q	m/yr	Uniform	--	2	—	1	3
α_L under the source	m	Derived from A: 0.05 ($\sqrt{A}$)	--	—	—	—	—
σ_L outside the source	m	Derived from X: 0.1 X	--	—	—	0	60

GENERIC RUN 5
HYDROGEOLOGIC CATEGORY: 4
CHEMICAL: 2,4 - DINITROTOLUENE

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	—	As defined by the CORR program

GENERIC RUN 6
HYDROGEOLOGIC CATEGORY: 4
CHEMICAL: ARSENIC*

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	—	0.0282	—	0.0226	0.0351
S	%	Exponential	—	0.295	—	0.1	1
B	m	Exponential	—	45	—	37	59
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.2	—	0.1	0.3
K_a	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_b	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_n	hr^{-1}	—	0	—	—	—	—
K_{oc}	ml/g	—	0	—	—	—	—
"ADI"	mg/l	—	2.33×10^{-6}	—	—	—	—
Anaerobic biodegradation	s^{-1}	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: $0.05 (\sqrt{A})$	—	—	—	—	—
α_L outside the source	m	Derived from X: $0.1\ X$	—	—	—	0	60

GENERIC RUN 6
HYDROGEOLOGIC CATEGORY: 4
CHEMICAL: ARSENIC*

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	--	As defined by the CORR program

* Note that, since all chemical and biological decay constants are zero for both arsenic and beryllium, one run will cover both chemicals up to the post-processing step (conversion of C_D to concentration at the source).

GENERIC RUN 8
HYDROGEOLOGIC CATEGORY: 4
CHEMICAL: NITRATE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	—	0.0282	—	0.0226	0.0351
S	%	Exponential	—	0.295	—	0.1	1
B	m	Exponential	—	45	—	37	59
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.2	—	0.1	0.3
K_a	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_b	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_n	hr^{-1}	—	0	—	—	—	—
K_{oc}	ml/g	—	0	—	—	—	—
"ADI"	mg/l	—	3.45	—	—	—	—
Anaerobic biodegradation	s^{-1}	—	3.2×10^{-6}	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: 0.05 ($\sqrt{A}$)	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 8
HYDROGEOLOGIC CATEGORY: 4
CHEMICAL: NITRATE

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	--	As defined by the CORR program

GENERIC RUN 9
HYDROGEOLOGIC CATEGORY: 5
CHEMICAL: CHLOROFORM

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	—	0.0076	—	0.0054	0.0106
S	%	Exponential	—	1.217	—	1	2
B	m	Exponential	—	31	—	28	35
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.18	—	0.05	0.30
K_a	$\mathrm{mole}^{-1}\mathrm{hr}^{-1}$	—	0	—	—	—	—
K_b	$\mathrm{mole}^{-1}\mathrm{hr}^{-1}$	—	0.23	—	—	—	—
K_n	hr^{-1}	—	3×10^{-9}	—	—	—	—
K_{oc}	ml/g	—	31	—	—	—	—
"ADI"	mg/l	—	4.3×10^{-4}	—	—	—	—
Anaerobic biodegradation	s^{-1}	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: $0.05 (\sqrt{A})$	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 9
HYDROGEOLOGIC CATEGORY: 5
CHEMICAL: CHLOROFORM

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\,\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\,\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	—	As defined by the CORR program

GENERIC RUN 10
HYDROGEOLOGIC CATEGORY: 5
CHEMICAL: HEXACHLOROBENZENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	—	0.0076	—	0.0054	0.0106
S	%	Exponential	—	1.217	—	1	2
B	m	Exponential	—	31	—	28	35
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.18	—	0.05	0.30
K_a	$\text{mole}^{-1}\text{hr}^{-1}$	--	0	—	—	—	—
K_b	$\text{mole}^{-1}\text{hr}^{-1}$	--	0	—	—	—	—
K_n	hr^{-1}	--	0	—	—	—	—
K_{oc}	ml/g	--	1.5×10^5	—	—	—	—
"ADI"	mg/l	--	2.1×10^{-5}	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
Anaeraobic biodegradation	S^{-1}	--	0	—	—	—	—
α_L under the source	m	Derived from A: 0.05 ($\sqrt{A}$)	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 10
HYDROGEOLOGIC CATEGORY: 5
CHEMICAL: HEXACHLOROBENZENE

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m ·	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	—	As defined by the CORR program

GENERIC RUN 11
HYDROGEOLOGIC CATEGORY: 5
CHEMICAL: TETRACHLOROETHYLENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	--	0.0076	--	0.0054	0.0106
S	%	Exponential	--	1.217	--	1	2
B	m	Exponential	--	31	--	28	35
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/yr	Uniform	--	0.18	--	0.05	0.30
K_a	$\text{mole}^{-1}\text{hr}^{-1}$	--	0	--	--	--	--
K_b	$\text{mole}^{-1}\text{hr}^{-1}$	--	0	--	--	--	--
K_n	hr^{-1}	--	0	--	--	--	--
K_{oc}	ml/g	--	209	--	--	--	--
"ADI"	mg/l	--	6.76×10^{-4}	--	--	--	--
Anaerobic biodegradation	s^{-1}	--	0	--	--	--	--
q	m/yr	Uniform	--	2	--	1	3
α_L under the source	m	Derived from A: 0.05 $(\sqrt{A})$	--	--	--	--	--
α_L outside the source	m	Derived from X: 0.1 X	--	--	--	0	60

GENERIC RUN 11
HYDROGEOLOGIC CATEGORY: 5
CHEMICAL: TETRACHLOROETHYLENE

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	—	As defined by the CORR program

GENERIC RUN 12
HYDROGEOLOGIC CATEGORY: 5
CHEMICAL: BENZENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	—	0.0076	—	0.0054	0.0106
S	%	Exponential	—	1.217	—	1	2
B	m	Exponential	—	31	—	28	35
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.18	—	0.05	0.30
K_a	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_b	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_n	hr^{-1}	—	0	—	—	—	—
K_{oc}	ml/g	—	59	-	—	—	—
"ADI"	mg/l	—	6.63×10^{-4}	—	—	—	—
Anaerobic biodegradation	s^{-1}	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: 0.05 ($\sqrt{A}$)	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 12
HYDROGEOLOGIC CATEGORY: 5
CHEMICAL: BENZENE

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9}(X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	--	As defined by the CORR program

GENERIC RUN 13
HYDROGEOLOGIC CATEGORY: 5
CHEMICAL: 2,4 - DINITROTOLUENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	—	0.0076	—	0.0054	0.0106
S	%	Exponential	—	1.217	—	1	2
B	m	Exponential	—	31	—	28	35
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.18	—	0.05	0.30
K_a	$mole^{-1}hr^{-1}$	—	0	—	—	—	—
K_b	$mole^{-1}hr^{-1}$	—	0	—	—	—	—
K_n	hr^{-1}	—	0	—	—	—	
K_{oc}	ml/g	—	76	-	—	—	—
"ADI"	mg/l	—	1.13×10^{-4}	—	—	—	—
Anaerobic biodegradation	s^{-1}	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: 0.05 ($\sqrt{A}$)	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 13
HYDROGEOLOGIC CATEGORY: 5
CHEMICAL: 2,4 - DINITROTOLUENE

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 \ (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} \ (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	--	As defined by the CORR program

GENERIC RUN 14
HYDROGEOLOGIC CATEGORY: 5
CHEMICAL: ARSENIC*

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	—	0.0076	—	0.0054	0.0106
S	%	Exponential	—	1.217	—	1	2
B	m	Exponential	—	31	—	28	35
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.18	—	0.05	0.30
K_a	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_b	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_n	hr^{-1}	—	0	—	—	—	
K_{oc}	ml/g	—	0	—	—	—	—
"ADI"	mg/l	—	2.33×10^{-6}	—	—	—	—
Anaerobic biodegradation	s^{-1}	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: $0.05\,(\sqrt{A})$	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 14
HYDROGEOLOGIC CATEGORY: 5
CHEMICAL: ARSENIC*

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	--	As defined by the CORR program

* Note that, since all chemical and biological decay constants are zero for both arsenic and beryllium, one run will cover both chemicals up to the post-processing step (conversion of C_D to concentration at the source).

GENERIC RUN 16
HYDROGEOLOGIC CATEGORY: 5
CHEMICAL: NITRATE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	--	0.0076	—	0.0054	0.0106
S	%	Exponential	--	1.217	—	1	2
B	m	Exponential	--	31	—	28	35
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/yr	Uniform	--	0.18	—	0.05	0.30
K_a	$\text{mole}^{-1}\text{hr}^{-1}$	--	0	--	—	—	--
K_b	$\text{mole}^{-1}\text{hr}^{-1}$	--	0	--	--	--	—
K_n	hr^{-1}	--	0	—	--	--	—
K_{oc}	ml/g	--	0	—	—	—	--
"ADI"	mg/l	—	3.45	—	—	—	—
Anaerobic biodegradation	s^{-1}	--	3.2×10^{-6}				
q	m/yr	Uniform	--	2	—	1	3
α_L under the source	m	Derived from A: 0.05 ($\sqrt{A}$)	—	—	--	—	—
α_L outside the source	m	Derived from X: 0.1 X	--	—	—	0	60

GENERIC RUN 16
HYDROGEOLOGIC CATEGORY: 5
CHEMICAL: NITRATE

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	--	As defined by the CORR program

GENERIC RUN 17
HYDROGEOLOGIC CATEGORY: 1
CHEMICAL: CHLOROFORM

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	—	0.0203	—	0.0183	0.0226
S	%	Exponential	—	0.295	—	0.1	1
B	m	Exponential	—	28	—	14	53
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	--	0.15	—	0	0.30
K_a	$mole^{-1}hr^{-1}$	--	0	—	—	—	—
K_b	$mole^{-1}hr^{-1}$	--	0.23	--	—	--	—
K_n	hr^{-1}	—	3×10^{-9}	—	—	—	—
K_{oc}	ml/g	—	31	—	—	—	—
"ADI"	mg/l	--	4.3×10^{-4}	—	—	—	—
Anaerobic biodegradation	s^{-1}	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: 0.05 $(\sqrt{A})$	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	--	--	—	0	60

GENERIC RUN 17
HYDROGEOLOGIC CATEGORY: 1
CHEMICAL: CHLOROFORM

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m .	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	--	As defined by the CORR program

GENERIC RUN 18
HYDROGEOLOGIC CATEGORY: 1
CHEMICAL: HEXACHLOROBENZENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	—	0.0203	—	0.0183	0.0226
S	%	Exponential	—	0.295	—	0.1	1
B	m	Exponential	—	28	—	14	53
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.15	—	0	0.30
K_a	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_b	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_n	hr^{-1}	—	0	—	—	—	—
K_{oc}	ml/g	—	1.5×10^5	—	—	—	—
"ADI"	mg/l	—	2.1×10^{-5}	—	—	—	—
Anaerobic biodegradation	s^{-1}	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: 0.05 ($\sqrt{A}$)	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 18
HYDROGEOLOGIC CATEGORY: 1
CHEMICAL: HEXACHLOROBENZENE

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 \ (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13} (X^3) - 2 \times 10^{-9} \ (X^2) + 1.22 \times 10^{-6} (X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	—	As defined by the CORR program

GENERIC RUN 19
HYDROGEOLOGIC CATEGORY: 1
CHEMICAL: TETRACHLOROETHYLENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	--	0.0203	—	0.0183	0.0226
S	%	Exponential	—	0.295	—	0.1	1
B	m	Exponential	—	28	—	14	53
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.15	—	0	0.30
K_a	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	--	—	—	—
K_b	$\text{mole}^{-1}\text{hr}^{-1}$	--	0	--	—	—	—
K_n	hr^{-1}	--	0	--	—	—	—
K_{oc}	ml/g	--	209	--	—	—	—
"ADI"	mg/l	--	6.76×10^{-4}	--	—	—	—
Anaerobic biodegradation	s^{-1}	--	0	--	—	--	--
q	m/yr	Uniform	--	2	—	1	3
α_L under the source	m	Derived from A: 0.05 ($\sqrt[4]{A}$)	--	--	—	—	--
α_L outside the source	m	Derived from X: 0.1 X	--	--	--	0	60

GENERIC RUN 19
HYDROGEOLOGIC CATEGORY: 1
CHEMICAL: TETRACHLOROETHYLENE

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	—	As defined by the CORR program

GENERIC RUN 20
HYDROGEOLOGIC CATEGORY: 1
CHEMICAL: BENZENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm.	$\log_{10}$ uniform	—	0.0203	—	0.0183	0.0226
S	%	Exponential	—	0.295	—	0.1	1
B	m	Exponential	—	28	—	14	53
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.15	—	0	0.30
K_a	$mole^{-1} hr^{-1}$	—	0	—	—	—	—
K_b	$mole^{-1} hr^{-1}$	—	0	—	—	—	—
K_n	hr^{-1}	—	0	—	—	—	—
K_{oc}	ml/g	—	59	—	—	—	—
"ADI"	mg/l	—	6.63×10^{-4}	—	—	—	—
Anaerobic biodegradation	s^{-1}	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: 0.05 ($\sqrt{A}$)	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 20
HYDROGEOLOGIC CATEGORY: 1
CHEMICAL: BENZENE

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	—	As defined by the CORR program

GENERIC RUN 21
HYDROGEOLOGIC CATEGORY: 1
CHEMICAL: 2,4 - DINITROTOLUENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	—	0.0203	—	0.0183	0.0226
S	%	Exponential	—	0.295	—	0.1	1
B	m	Exponential	—	28	—	14	53
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.15	—	0	0.30
K_a	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_b	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_n	hr^{-1}	—	0	—	—	—	—
K_{oc}	ml/g	—	76	—	—	—	—
"ADI"	mg/l	—	1.13×10^{-4}	—	—	—	—
Anaerobic biodegradation	s^{-1}	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: 0.05 ($\sqrt{A}$)	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 21
HYDROGEOLOGIC CATEGORY: 1
CHEMICAL: 2,4 - DINITROTOLUENE

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	---	As defined by the CORR program

GENERIC RUN 22
HYDROGEOLOGIC CATEGORY: 1
CHEMICAL: ARSENIC*

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	—	0.0203	—	0.0183	0.0226
S	%	Exponential	—	0.295	—	0.1	1
B	m	Exponential	—	28	—	14	53
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.15	—	0	0.30
K_a	$\mathrm{mole}^{-1}\mathrm{hr}^{-1}$	—	0	—	—	—	—
K_b	$\mathrm{mole}^{-1}\mathrm{hr}^{-1}$	—	0	—	—	—	—
K_n	hr^{-1}	—	0	—	—	—	—
K_{oc}	ml/g	—	0	—	—	—	—
"ADI"	mg/l	—	2.33×10^{-6}	—	—	—	—
Anaerobic biodegradation	s^{-1}	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: 0.05 ($\sqrt{A}$)	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 22
HYDROGEOLOGIC CATEGORY: 1
CHEMICAL: ARSENIC*

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	--	As defined by the CORR program

* Note that, since all chemical and biological decay constants are zero for both arsenic and beryllium, one run will cover both chemicals up to the post-processing step (conversion of C_D to concentration at the source).

GENERIC RUN 24
HYDROGEOLOGIC CATEGORY: 1
CHEMICAL: NITRATE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	--	0.0203	—	0.0183	0.0226
S	%	Exponential	--	0.295	—	0.1	1
B	m	Exponential	--	28	—	14	53
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.15	—	0	0.30
K_a	$\text{mole}^{-1}\text{hr}^{-1}$	--	0	—	—	—	—
K_b	$\text{mole}^{-1}\text{hr}^{-1}$	--	0	—	—	—	--
K_n	hr^{-1}	--	0	—	—	—	--
K_{oc}	ml/g	—	0	—	—	—	--
"ADI"	mg/l	--	3.45	—	—	--	--
Anaerobic biodegradation	s^{-1}	--	3.2×10^{-6}	—	—	—	—
q	m/yr	Uniform	--	2	—	1	3
α_L under the source	m	Derived from A: 0.05 ($\sqrt{A}$)	--	—	—	—	--
α_L outside the source	m	Derived from X: 0.1 X	--	—	—	0	60

GENERIC RUN 24
HYDROGEOLOGIC CATEGORY: 1
CHEMICAL: NITRATE

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	—	As defined by the CORR program

GENERIC RUN 25
HYDROGEOLOGIC CATEGORY: 2
CHEMICAL: CHLOROFORM

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	—	0.0139	—	0.0106	0.0183
S	%	Exponential	—	0.295	—	0.1	1
B	m	Exponential	—	31	—	20	55
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/yr	Uniform	--	0.025	—	0	0.05
K_a	$\text{mole}^{-1}\text{hr}^{-1}$	--	0	--	—	--	--
K_b	$\text{mole}^{-1}\text{hr}^{-1}$	--	0.23	--	—	—	—
K_n	hr^{-1}	--	3×10^{-9}	--	—	--	--
K_{oc}	ml/g	—	31	—	—	—	—
"ADI"	mg/l	—	4.3×10^{-4}	—	—	--	—
Anaerobic biodegradation	s^{-1}	—	0	—	—	—	—
q	m/yr	Uniform	--	2	--	1	3
α_L under the source	m	Derived from A: 0.05 ($\sqrt{A}$)	--	—	—	--	—
α_L outside the source	m	Derived from X: 0.1 X	--	—	--	0	60

GENERIC RUN 25
HYDROGEOLOGIC CATEGORY: 2
CHEMICAL: CHLOROFORM

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	--	As defined by the CORR program

GENERIC RUN 26
HYDROGEOLOGIC CATEGORY: 2
CHEMICAL: HEXACHLOROBENZENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	—	0.0139	—	0.0106	0.0183
S	%	Exponential	—	0.295	—	0.1	1
B	m	Exponential	—	31	—	20	55
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.025	—	0	0.05
K_a	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_b	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_n	hr^{-1}	—	0	—	—	—	—
K_{oc}	ml/g	—	1.5×10^5	—	—	—	—
"ADI"	mg/l	—	2.1×10^{-5}	—	—	—	—
Anaerobic biodegradation	s^{-1}	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: 0.05 ($\sqrt{A}$)	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 26
HYDROGEOLOGIC CATEGORY: 2
CHEMICAL: HEXACHLOROBENZENE

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	--	As defined by the CORR program

GENERIC RUN 27
HYDROGEOLOGIC CATEGORY: 2
CHEMICAL: TETRACHLOROETHYLENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	—	0.0139	—	0.0106	0.0183
S	%	Exponential	—	0.295	—	0.1	1
B	m	Exponential	—	31	—	20	55
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.025	—	0	0.05
K_a	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_b	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_n	hr^{-1}	—	0	—	—	—	—
K_{oc}	ml/g	—	209	—	—	—	—
"ADI"	mg/l	—	6.76×10^{-4}	—	—	—	—
Anaerobic biodegradation	s^{-1}	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: 0.05 ($\sqrt{A}$)	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 27
HYDROGEOLOGIC CATEGORY: 2
CHEMICAL: TETRACHLOROETHYLENE

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	—	As defined by the CORR program

GENERIC RUN 28
HYDROGEOLOGIC CATEGORY: 2
CHEMICAL: BENZENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	$\log_{10}$ uniform	—	0.0139	—	0.0106	0.0183
S	%	Exponential	—	0.295	—	0.1	1
B	m	Exponential	—	31	—	20	55
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.025	—	0	0.05
K_a	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_b	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_n	hr^{-1}	—	0	—	—	—	—
K_{oc}	ml/g	—	59	—	—	—	—
"ADI"	mg/l	—	6.63×10^{-4}	—	—	—	—
Anaerobic biodegradation	s^{-1}	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: $0.05 (\sqrt{A})$	—	—	—	—	—
α_L outside the source	m	Derived from X: $0.1 X$	—	—	—	0	60

GENERIC RUN 28
HYDROGEOLOGIC CATEGORY: 2
CHEMICAL: BENZENE

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	--	As defined by the CORR program

GENERIC RUN 29
HYDROGEOLOGIC CATEGORY: 2
CHEMICAL: 2,4 - DINITROTOLUENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	—	0.0139	—	0.0106	0.0183
S	%	Exponential	—	0.295	—	0.1	1
B	m	Exponential	—	31	—	20	55
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.025	—	0	0.05
K_a	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_b	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_n	hr^{-1}	—	0	—	—	—	—
K_{oc}	ml/g	—	76	—	—	—	—
"ADI"	mg/l	—	1.13×10^{-4}	—	—	—	—
Anaerobic biodegradation	s^{-1}	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: $0.05\ (\sqrt{A})$	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 29
HYDROGEOLOGIC CATEGORY: 2
CHEMICAL: 2,4 - DINITROTOLUENE

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	—	As defined by the CORR program

GENERIC RUN 30
HYDROGEOLOGIC CATEGORY: 2
CHEMICAL: ARSENIC*

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	—	0.0139	—	0.0106	0.0183
S	%	Exponential	—	0.295	—	0.1	1
B	m	Exponential	—	31	—	20	55
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.025	—	0	0.05
K_a	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_b	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_n	hr^{-1}	—	0	—	—	—	—
K_{oc}	ml/g	—	0	—	—	—	—
"ADI"	mg/l	—	2.33×10^{-6}	—	—	—	—
Anaerobic biodegradation	s^{-1}	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: $0.05(\sqrt{A})$	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 30
HYDROGEOLOGIC CATEGORY: 2
CHEMICAL: ARSENIC*

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	—	As defined by the CORR program

* Note that, since all chemical and biological decay constants are zero for both arsenic and beryllium, one run will cover both chemicals up to the post-processing step (conversion of C_D to concentration at the source).

GENERIC RUN 32
HYDROGEOLOGIC CATEGORY: 2
CHEMICAL: NITRATE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	—	0.0139	—	0.0106	0.0183
S	%	Exponential	—	0.295	—	0.1	1
B	m	Exponential	—	31	—	20	55
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.025	—	0	0.05
K_a	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_b	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_n	hr^{-1}	—	0	—	—	—	—
K_{oc}	ml/g	—	0	—	—	—	—
"ADI"	mg/l	—	3.45	—	—	—	—
Anaerobic biodegradation	s^{-1}	—	3.2×10^{-6}	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: 0.05 ($\sqrt{A}$)	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 32
HYDROGEOLOGIC CATEGORY: 2
CHEMICAL: NITRATE

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	--	As defined by the CORR program

GENERIC RUN 33
HYDROGEOLOGIC CATEGORY: 3
CHEMICAL: CHLOROFORM

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	—	0.0351	—	0.0351	0.0351
S	%	Exponential	—	0.295	—	0.1	1
B	m	Exponential	—	33	—	33	33
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.025	—	0	0.05
K_a	$mole^{-1}hr^{-1}$	—	0	—	—	—	—
K_b	$mole^{-1}hr^{-1}$	—	0.23	—	—	—	—
K_n	hr^{-1}	—	3×10^{-9}	—	—	—	—
K_{oc}	ml/g	—	31	—	—	—	—
"ADI"	mg/l	—	4.3×10^{-4}	—	—	—	—
Anaerobic biodegradation	s^{-1}	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: 0.05 ($\sqrt{A}$)	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 33
HYDROGEOLOGIC CATEGORY: 3
CHEMICAL: CHLOROFORM

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\,\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	—	As defined by the CORR program

GENERIC RUN 34
HYDROGEOLOGIC CATEGORY: 3
CHEMICAL: HEXACHLOROBENZENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	—	0.0351	—	0.0351	0.0351
S	%	Exponential	—	0.295	—	0.1	1
B	m	Exponential	—	33	—	33	33
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.025	—	0	0.05
K_a	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_b	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_n	hr^{-1}	—	0	—	—	—	—
K_{oc}	ml/g	—	1.5×10^5	—	—	—	—
"ADI"	mg/l	—	2.1×10^{-5}	—	—	—	—
Anaerobic biodegradation	s^{-1}	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: 0.05 $(\sqrt{A})$	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	--	--	—	0	60

GENERIC RUN 34
HYDROGEOLOGIC CATEGORY: 3
CHEMICAL: HEXACHLOROBENZENE

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	—	As defined by the CORR program

GENERIC RUN 35
HYDROGEOLOGIC CATEGORY: 3
CHEMICAL: TETRACHLOROETHYLENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	--	0.0351	--	0.0351	0.0351
S	%	Exponential	--	0.295	--	0.1	1
B	m	Exponential	--	33	--	33	33
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/yr	Uniform	--	0.025	--	0	0.05
K_a	$mole^{-1}hr^{-1}$	--	0	--	--	--	--
K_b	$mole^{-1}hr^{-1}$	--	0	--	--	--	--
K_n	hr^{-1}	--	0	--	--	--	--
K_{oc}	ml/g	--	209	--	--	--	--
"ADI"	mg/l	--	6.76×10^{-4}	--	--	--	--
Anaerobic biodegradation	s^{-1}	--	0	--	--	--	--
q	m/yr	Uniform	--	2	--	1	3
α_L under the source	m	Derived from A: 0.05 ($\sqrt{A}$)	--	--	--	--	--
α_L outside the source	m	Derived from X: 0.1 X	--	--	--	0	60

GENERIC RUN 35
HYDROGEOLOGIC CATEGORY: 3
CHEMICAL: TETRACHLOROETHYLENE

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	--	As defined by the CORR program

GENERIC RUN 36
HYDROGEOLOGIC CATEGORY: 3
CHEMICAL: BENZENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	$\log_{10}$ uniform	—	0.0351	—	0.0351	0.0351
S	%	Exponential	—	0.295	—	0.1	1
B	m	Exponential	—	33	—	33	33
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.025	—	0	0.05
K_a	$mole^{-1} hr^{-1}$	—	0	—	—	—	—
K_b	$mole^{-1} hr^{-1}$	—	0	—	—	—	—
K_n	hr^{-1}	—	0	—	—	—	—
K_{oc}	ml/g	—	59	—	—	—	—
"ADI"	mg/l	--	6.63×10^{-4}	—	—	—	—
Anaerobic biodegradation	s^{-1}	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: 0.05 ($\sqrt{A}$)	—	—	—	—	--
α_L outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 36
HYDROGEOLOGIC CATEGORY: 3
CHEMICAL: BENZENE

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	—	As defined by the CORR program

GENERIC RUN 37
HYDROGEOLOGIC CATEGORY: 3
CHEMICAL: 2,4 - DINITROTOLUENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	—	0.0351	—	0.0351	0.0351
S	%	Exponential	—	0.295	—	0.1	1
B	m	Exponential	—	33	—	33	33
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.025	—	0	0.05
K_a	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_b	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_n	hr^{-1}	—	0	—	—	—	—
K_{oc}	ml/g	—	76	—	—	—	—
"ADI"	mg/l	—	1.13×10^{-4}	—	—	—	—
Anaerobic biodegradation	s^{-1}	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: 0.05 ($\sqrt{A}$)	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	--	—	—	0	60

GENERIC RUN 37
HYDROGEOLOGIC CATEGORY: 3
CHEMICAL: 2,4 - DINITROTOLUENE

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m.	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	—	As defined by the CORR program

GENERIC RUN 38
HYDROGEOLOGIC CATEGORY: 3
CHEMICAL: ARSENIC*

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	—	0.0351	—	0.0351	0.0351
S	%	Exponential	—	0.295	—	0.1	1
B	m	Exponential	—	33	—	33	33
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.025	—	0	0.05
K_a	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_b	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_n	hr^{-1}	—	0	—	—	—	—
K_{oc}	ml/g	—	0	—	—	—	—
"ADI"	mg/l	—	2.33×10^{-6}	—	—	—	—
Anaerobic biodegradation	s^{-1}	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: 0.05 ($\sqrt{A}$)	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 38
HYDROGEOLOGIC CATEGORY: 3
CHEMICAL: ARSENIC*

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	--	As defined by the CORR program

* Note that, since all chemical and biological decay constants are zero for both arsenic and beryllium, one run will cover both chemicals up to the post-processing step (conversion of C_D to concentration at the source).

GENERIC RUN 40
HYDROGEOLOGIC CATEGORY: 3
CHEMICAL: NITRATE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	—	0.0351	—	0.0351	0.0351
S	%	Exponential	—	0.295	—	0.1	1
B	m	Exponential	—	33	—	33	33
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.025	—	0	0.05
K_a	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_b	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_n	hr^{-1}	—	0	—	—	—	—
K_{oc}	ml/g	—	0	—	—	—	—
"ADI"	mg/l	—	3.45	—	—	—	—
Anaerobic biodegradation	s^{-1}	—	3.2×10^{-6}	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: 0.05 ($\sqrt{A}$)	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 40
HYDROGEOLOGIC CATEGORY: 3
CHEMICAL: NITRATE

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	—	As defined by the CORR program

GENERIC RUN 41
HYDROGEOLOGIC CATEGORY: 6
CHEMICAL: CHLOROFORM

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	--	0.0013	—	0.0003	0.0054
S	%	Exponential	—	1.217	—	1	2
B	m	Exponential	--	58	—	33	100
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	--	0.09	--	0	0.18
K_a	$\mathrm{mole}^{-1}\mathrm{hr}^{-1}$	--	0	—	--	—	—
K_b	$\mathrm{mole}^{-1}\mathrm{hr}^{-1}$	--	0.23	—	—	--	--
K_n	hr^{-1}	--	3×10^{-9}	—	—	--	--
K_{oc}	ml/g	—	31	--	—	—	—
"ADI"	mg/l	--	4.3×10^{-4}	--	--	—	—
Anaerobic biodegradation	s^{-1}	—	0	—	—	—	--
q	m/yr	Uniform	--	2	—	1	3
α_L under the source	m	Derived from A: 0.05 ($\sqrt{A}$)	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	--	--	--	0	60

GENERIC RUN 41
HYDROGEOLOGIC CATEGORY: 6
CHEMICAL: CHLOROFORM

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 \; (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9}\;(X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	—	As defined by the CORR program

GENERIC RUN 42
HYDROGEOLOGIC CATEGORY: 6
CHEMICAL: HEXACHLOROBENZENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	—	0.0013	—	0.0003	0.0054
S	%	Exponential	--	1.217	—	1	2
B	m	Exponential	—	58	—	33	100
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	--	0.09	—	0	0.18
K_a	$\text{mole}^{-1}\text{hr}^{-1}$	--	0	—	—	—	--
K_b	$\text{mole}^{-1}\text{hr}^{-1}$	--	0	—	—	—	—
K_n	hr^{-1}	--	0	—	—	—	—
K_{oc}	ml/g	—	1.5×10^5	—	—	—	—
"ADI"	mg/l	--	2.1×10^{-5}	—	—	—	—
Anaerobic biodegradation	s^{-1}	--	0	—	—	—	—
q	m/yr	Uniform	--	2	—	1	3
α_L under the source	m	Derived from A: 0.05 ($\sqrt{A}$)	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 42
HYDROGEOLOGIC CATEGORY: 6
CHEMICAL: HEXACHLOROBENZENE

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m .	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	—	As defined by the CORR program

GENERIC RUN 43
HYDROGEOLOGIC CATEGORY: 6
CHEMICAL: TETRACHLOROETHYLENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	—	0.0013	—	0.0003	0.0054
S	%	Exponential	—	1.217	—	1	2
B	m	Exponential	—	58	—	33	100
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.09	—	0	0.18
K_a	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_b	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_n	hr^{-1}	—	0	—	—	—	—
K_{oc}	ml/g	—	209	—	—	—	—
"ADI"	mg/l	—	6.76×10^{-4}	—	—	—	—
Anaerobic biodegradation	s^{-1}	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: 0.05 ($\sqrt{A}$)	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 43
HYDROGEOLOGIC CATEGORY: 6
CHEMICAL: TETRACHLOROETHYLENE

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	—	As defined by the CORR program

GENERIC RUN 44
HYDROGEOLOGIC CATEGORY: 6
CHEMICAL: BENZENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	—	0.0013	—	0.0003	0.0054
S	%	Exponential	—	1.217	—	1	2
B	m	Exponential	—	58	—	33	100
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.09	—	0	0.18
K_a	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_b	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_n	hr^{-1}	—	0	—	—	—	—
K_{oc}	ml/g	—	59	—	—	—	—
"ADI"	mg/l	—	6.63×10^{-4}	—	—	—	—
Anaerobic biodegradation	s^{-1}	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: 0.05 $(\sqrt{A})$	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 44
HYDROGEOLOGIC CATEGORY: 6
CHEMICAL: BENZENE

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	—	As defined by the CORR program

GENERIC RUN 45
HYDROGEOLOGIC CATEGORY: 6
CHEMICAL: 2,4-DINITROTOLUENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	—	0.0013	—	0.0003	0.0054
S	%	Exponential	—	1.217	—	1	2
B	m	Exponential	—	58	—	33	100
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.09	—	0	0.18
K_a	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_b	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_n	hr^{-1}	—	0	—	—	—	—
K_{oc}	ml/g	—	76	—	—	—	—
"ADI"	mg/l	—	1.13×10^{-4}	—	—	—	—
Anaerobic biodegradation	s^{-1}	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: 0.05 ($\sqrt{A}$)	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 45
HYDROGEOLOGIC CATEGORY: 6
CHEMICAL: 2,4-DINITROTOLUENE

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	--	As defined by the CORR program

GENERIC RUN 46
HYDROGEOLOGIC CATEGORY: 6
CHEMICAL: ARSENIC

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	—	0.0013	—	0.0003	0.0054
S	%	Exponential	—	1.217	—	1	2
B	m	Exponential	—	58	—	33	100
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.09	—	0	0.18
K_a	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_b	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_n	hr^{-1}	—	0	—	—	—	—
K_{oc}	ml/g	—	0	—	—	—	—
"ADI"	mg/l	—	2.33×10^{-6}	—	—	—	—
Anaerobic biodegradation	s^{-1}	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: 0.05 ($\sqrt{A}$)	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 46
HYDROGEOLOGIC CATEGORY: 6
CHEMICAL: ARSENIC*

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	--	As defined by the CORR program

* Note that, since all chemical and biological decay constants are zero for both arsenic and beryllium, one run will cover both chemicals up to the post-processing step (conversion of C_D to concentration at the source).

GENERIC RUN 48
HYDROGEOLOGIC CATEGORY: 6
CHEMICAL: NITRATE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	—	0.0013	—	0.0003	0.0054
S	%	Exponential	—	1.217	—	1	2
B	m	Exponential	—	58	—	33	100
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.09	—	0	0.18
K_a	$\mathrm{mole}^{-1}\mathrm{hr}^{-1}$	—	0	—	—	—	—
K_b	$\mathrm{mole}^{-1}\mathrm{hr}^{-1}$	—	0	—	—	—	—
K_n	hr^{-1}	—	0	—	—	—	—
K_{oc}	ml/g	—	0	—	—	—	—
"ADI"	mg/l	—	3.45	—	—	—	—
Anaerobic biodegradation	s^{-1}	—	3.2×10^{-6}	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: 0.05 $(\sqrt{A})$	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 48
HYDROGEOLOGIC CATEGORY: 6
CHEMICAL: NITRATE

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	--	As defined by the CORR program

GENERIC RUN 49
HYDROGEOLOGIC CATEGORY: 7
CHEMICAL: CHLOROFORM

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	—	0.0013	—	0.0003	0.0054
S	%	Exponential	—	0.717	—	0.5	1.5
B	m	Exponential	—	58	—	33	100
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	--	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.14	—	0.10	0.18
K_a	$\text{mole}^{-1}\text{hr}^{-1}$	--	0	—	—	—	—
K_b	$\text{mole}^{-1}\text{hr}^{-1}$	--	0.23	—	—	—	—
K_n	hr^{-1}	--	3×10^{-9}	—	—	—	—
K_{oc}	ml/g	—	31	—	—	—	—
"ADI"	mg/l	—	4.3×10^{-4}	—	—	—	—
Anaerobic biodegradation	s^{-1}	--	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: 0.05 ($\sqrt{A}$)	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	--	—	—	0	60

GENERIC RUN 49
HYDROGEOLOGIC CATEGORY: 7
CHEMICAL: CHLOROFORM

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 \ (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} \ (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	—	As defined by the CORR program

GENERIC RUN 50
HYDROGEOLOGIC CATEGORY: 7
CHEMICAL: HEXACHLOROBENZENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	—	0.0013	—	0.0003	0.0054
S	%	Exponential	—	0.717	—	0.5	1.5
B	m	Exponential	—	58	—	33	100
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.14	—	0.10	0.18
K_a	$\mathrm{mole}^{-1}\mathrm{hr}^{-1}$	—	0	—	—	—	—
K_b	$\mathrm{mole}^{-1}\mathrm{hr}^{-1}$	—	0	—	—	—	—
K_n	hr^{-1}	—	0	—	—	—	—
K_{oc}	ml/g	—	1.5×10^{5}	—	—	—	—
"ADI"	mg/l	—	2.1×10^{-5}	—	—	—	—
Anaerobic biodegradation	s^{-1}	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: $0.05\ (\sqrt{A})$	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 50
HYDROGEOLOGIC CATEGORY: 7
CHEMICAL: HEXACHLOROBENZENE

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	—	As defined by the CORR program

GENERIC RUN 51
HYDROGEOLOGIC CATEGORY: 7
CHEMICAL: TETRACHLOROETHYLENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	—	0.0013	—	0.0003	0.0054
S	%	Exponential	—	0.717	—	0.5	1.5
B	m	Exponential	—	58	—	33	100
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.14	—	0.10	0.18
K_a	$mole^{-1}hr^{-1}$	—	0	—	—	—	—
K_b	$mole^{-1}hr^{-1}$	—	0	—	—	—	—
K_n	hr^{-1}	—	0	—	—	—	—
K_{oc}	ml/g	—	209	—	—	—	—
"ADI"	mg/l	—	6.76×10^{-4}	—	—	—	—
Anaerobic biodegradation	s^{-1}	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: 0.05 ($\sqrt{A}$)	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 51
HYDROGEOLOGIC CATEGORY: 7
CHEMICAL: TETRACHLOROETHYLENE

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	--	As defined by the CORR program

GENERIC RUN 52
HYDROGEOLOGIC CATEGORY: 7
CHEMICAL: BENZENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	—	0.0013	—	0.0003	0.0054
S	%	Exponential	—	0.717	—	0.5	1.5
B	m	Exponential	—	58	—	33	100
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.14	—	0.10	0.18
K_a	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_b	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_n	hr^{-1}	—	0	—	—	—	—
K_{oc}	ml/g	—	59	—	—	—	—
"ADI"	mg/l	—	6.63×10^{-4}	—	—	—	—
Anaerobic biodegradation	s^{-1}	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: $0.05\ (\sqrt{A})$	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 52
HYDROGEOLOGIC CATEGORY: 7
CHEMICAL: BENZENE

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	--	As defined by the CORR program

GENERIC RUN 53
HYDROGEOLOGIC CATEGORY: 7
CHEMICAL: 2,4 - DINITROTOLUENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	—	0.0013	—	0.0003	0.0054
S	%	Exponential	—	0.717	—	0.5	1.5
B	m	Exponential	—	58	—	33	100
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	--	0.14	—	0.10	0.18
K_a	$\text{mole}^{-1}\text{hr}^{-1}$	--	0	—	—	—	—
K_b	$\text{mole}^{-1}\text{hr}^{-1}$	--	0	—	—	—	—
K_n	hr^{-1}	—	0	—	—	—	—
K_{oc}	ml/g	—	76	—	—	—	—
"ADI"	mg/l	—	1.13×10^{-4}	—	—	—	—
Anaerobic biodegradation	s^{-1}	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: 0.05 ($\sqrt{A}$)	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 53
HYDROGEOLOGIC CATEGORY: 7
CHEMICAL: 2,4 - DINITROTOLUENE

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^{4} (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^{3}) - 2 \times 10^{-9} (X^{2}) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	—	As defined by the CORR program

GENERIC RUN 54
HYDROGEOLOGIC CATEGORY: 7
CHEMICAL: ARSENIC*

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm.	Log_{10} uniform	—	0.0013	—	0.0003	0.0054
S	%	Exponential	—	0.717	—	0.5	1.5
B	m	Exponential	—	58	—	33	100
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.14	—	0.10	0.18
K_a	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_b	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_n	hr^{-1}	—	0	—	—	—	—
K_{oc}	ml/g	—	0	—	—	—	—
"ADI"	mg/l	—	2.33×10^{-6}	—	—	—	—
Anaerobic biodegradation	s^{-1}	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: 0.05 ($\sqrt{A}$)	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 54
HYDROGEOLOGIC CATEGORY: 7
CHEMICAL: ARSENIC*

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	—	As defined by the CORR program

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* Note that, since all chemical and biological decay constants are zero for both arsenic and beryllium, one run will cover both chemicals up to the post-processing step (conversion of C_D to concentration at the source).

GENERIC RUN 56
HYDROGEOLOGIC CATEGORY: 7
CHEMICAL: NITRATE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	—	0.0013	—	0.0003	0.0054
S	%	Exponential	—	0.717	—	0.5	1.5
B	m	Exponential	—	58	—	33	100
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.14	—	0.10	0.18
K_a	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_b	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_n	hr^{-1}	—	0	—	—	—	—
K_{oc}	ml/g	—	0	—	—	—	—
"ADI"	mg/l	—	3.45	—	—	—	—
Anaerobic biodegradation	s^{-1}	—	3.2×10^{-6}	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: 0.05 $(\sqrt{A})$	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 56
HYDROGEOLOGIC CATEGORY: 7
CHEMICAL: NITRATE

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	--	As defined by the CORR

GENERIC RUN 57
HYDROGEOLOGIC CATEGORY: 8
CHEMICAL: CHLOROFORM

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	$\log_{10}$ uniform	—	0.0139	—	0.0106	0.0183
S	%	Exponential	—	0.717	—	0.5	1.5
B	m	Exponential	—	18	—	7	50
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.14	—	0.10	0.18
K_a	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_b	$\text{mole}^{-1}\text{hr}^{-1}$	—	0.23	—	—	—	—
K_n	hr^{-1}	—	3×10^{-9}	—	—	—	—
K_{oc}	ml/g	—	31	—	—	—	—
"ADI"	mg/l	—	4.3×10^{-4}	—	—	—	—
Anaerobic biodegradation	s^{-1}	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: 0.05 $(\sqrt{A})$	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 57
HYDROGEOLOGIC CATEGORY: 8
CHEMICAL: CHLOROFORM

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	—	As defined by the CORR program

GENERIC RUN 58
HYDROGEOLOGIC CATEGORY: 8
CHEMICAL: HEXACHLOROBENZENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	—	0.0139	—	0.0106	0.0183
S	%	Exponential	—	0.717	—	0.5	1.5
B	m	Exponential	—	18	—	7	50
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.14	—	0.10	0.18
K_a	$mole^{-1}hr^{-1}$	—	0	—	—	—	—
K_b	$mole^{-1}hr^{-1}$	—	0	—	—	—	—
K_n	hr^{-1}	—	0	—	—	—	—
K_{oc}	ml/g	—	1.5×10^5	—	—	—	—
"ADI"	mg/l	—	2.1×10^{-5}	—	—	—	—
Anaerobic biodegradation	s^{-1}	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: 0.05 $(\sqrt{A})$	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 58
HYDROGEOLOGIC CATEGORY: 8
CHEMICAL: HEXACHLOROBENZENE

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	--	As defined by the CORR program

GENERIC RUN 59
HYDROGEOLOGIC CATEGORY: 8
CHEMICAL: TETRACHLOROETHYLENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	—	0.0139	—	0.0106	0.0183
S	%	Exponential	—	0.717	—	0.5	1.5
B	m	Exponential	—	18	—	7	50
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.14	—	0.10	0.18
K_a	$\mathrm{mole}^{-1}\mathrm{hr}^{-1}$	—	0	—	—	—	—
K_b	$\mathrm{mole}^{-1}\mathrm{hr}^{-1}$	—	0	—	—	—	—
K_n	hr^{-1}	—	0	—	—	—	—
K_{oc}	ml/g	—	209	—	—	—	
"ADI"	mg/l	—	6.76×10^{-4}	—	—	—	—
Anaerobic biodegradation	s^{-1}	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: $0.05 (\sqrt{A})$	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 59
HYDROGEOLOGIC CATEGORY: 8
CHEMICAL: TETRACHLOROETHYLENE

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	—	As defined by the CORR program

GENERIC RUN 60
HYDROGEOLOGIC CATEGORY: 8
CHEMICAL: BENZENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	—	0.0139	—	0.0106	0.0183
S	%	Exponential	—	0.717	—	0.5	1.5
B	m	Exponential	—	18	—	7	50
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.14	—	0.10	0.18
K_a	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_b	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_n	hr^{-1}	—	0	—	—	—	—
K_{oc}	ml/g	—	59	—	—	—	—
"ADI"	mg/l	—	6.63×10^{-4}	—	—	—	—
Anaerobic biodegradation	s^{-1}	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: $0.05 (\sqrt{A})$	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 60
HYDROGEOLOGIC CATEGORY: 8
CHEMICAL: BENZENE

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	--	As defined by the CORR program

GENERIC RUN 61
HYDROGEOLOGIC CATEGORY: 8
CHEMICAL: 2,4 - DINITROTOLUENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	$\log_{10}$ uniform	—	0.0139	—	0.0106	0.0183
S	%	Exponential	—	0.717	—	0.5	1.5
B	m	Exponential	—	18	—	7	50
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.14	—	0.10	0.18
K_a	$mole^{-1}hr^{-1}$	—	0	—	—	—	—
K_b	$mole^{-1}hr^{-1}$	—	0	—	—	—	—
K_n	hr^{-1}	—	0	—	—	—	—
K_{oc}	ml/g	—	76	—	—	—	—
"ADI"	mg/l	—	1.13×10^{-4}	—	—	—	—
Anaerobic biodegradation	s^{-1}	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: 0.05 ($\sqrt{A}$)	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 61
HYDROGEOLOGIC CATEGORY: 8
CHEMICAL: 2,4 - DINITROTOLUENE

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	--	As defined by the CORR program

GENERIC RUN 62
HYDROGEOLOGIC CATEGORY: 8
CHEMICAL: ARSENIC*

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	—	0.0139	—	0.0106	0.0183
S	%	Exponential	—	0.717	—	0.5	1.5
B	m	Exponential	—	18	—	7	50
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.14	—	0.10	0.18
K_a	$\mathrm{mole}^{-1}\mathrm{hr}^{-1}$	—	0	—	—	—	—
K_b	$\mathrm{mole}^{-1}\mathrm{hr}^{-1}$	—	0	—	—	—	—
K_n	hr^{-1}	—	0	—	—	—	—
K_{oc}	ml/g	—	0	—	—	—	—
"ADI"	mg/l	—	2.33×10^{-6}	—	—	—	—
Anaerobic biodegradation	s^{-1}	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: 0.05 ($\sqrt{A}$)	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 62
HYDROGEOLOGIC CATEGORY: 8
CHEMICAL: ARSENIC*

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	--	As defined by the CORR program

* Note that, since all chemical and biological decay constants are zero for both arsenic and beryllium, one run will cover both chemicals up to the post-processing step (conversion of C_D to concentration at the source).

GENERIC RUN 64
HYDROGEOLOGIC CATEGORY: 8
CHEMICAL: NITRATE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	—	0.0139	—	0.0106	0.0183
S	%	Exponential	—	0.717	—	0.5	1.5
B	m	Exponential	—	18	—	7	50
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.14	—	0.10	0.18
K_a	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_b	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_n	hr^{-1}	—	0	—	—	—	—
K_{oc}	ml/g	—	0	—	—	—	—
"ADI"	mg/l	—	3.45	—	—	—	—
Anaerobic biodegradation	s^{-1}	—	3.2×10^{-6}	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: 0.05 ($\sqrt{A}$)	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 64
HYDROGEOLOGIC CATEGORY: 8
CHEMICAL: NITRATE

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	--	As defined by the CORR program

GENERIC RUN 65
HYDROGEOLOGIC CATEGORY: 9
CHEMICAL: CHLOROFORM

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	—	0.0013	—	0.0003	0.0054
S	%	Exponential	—	0.717	—	0.5	1.5
B	m	Exponential	—	18	—	7	50
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.14	—	0.10	0.18
K_a	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_b	$\text{mole}^{-1}\text{hr}^{-1}$	—	0.23	—	—	—	—
K_n	hr^{-1}	—	3×10^{-9}	—	—	—	—
K_{oc}	ml/g	—	31	—	—	—	—
"ADI"	mg/l	—	4.3×10^{-4}	—	—	—	—
Anaerobic biodegradation	s^{-1}	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: 0.05 ($\sqrt{A}$)	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 65
HYDROGEOLOGIC CATEGORY: 9
CHEMICAL: CHLOROFORM

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 \ (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} \ (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	—	As defined by the CORR program

GENERIC RUN 66
HYDROGEOLOGIC CATEGORY: 9
CHEMICAL: HEXACHLOROBENZENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	—	0.0013	—	0.0003	0.0054
S	%	Exponential	—	0.717	—	0.5	1.5
B	m	Exponential	—	18	—	7	50
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.14	—	0.10	0.18
K_a	$mole^{-1} hr^{-1}$	—	0	—	—	—	—
K_b	$mole^{-1} hr^{-1}$	--	0	—	—	—	—
K_n	hr^{-1}	—	0	—	—	—	—
K_{oc}	ml/g	—	1.5×10^5	—	—	—	—
"ADI"	mg/l	—	2.1×10^{-5}	—	—	—	—
Anaerobic biodegradation	s^{-1}	—	0	—	—	—	—
q	m/yr	Uniform	-	2	—	1	3
α_L under the source	m	Derived from A: 0.05 ($\sqrt{A}$)	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 66
HYDROGEOLOGIC CATEGORY: 9
CHEMICAL: HEXACHLOROBENZENE

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	--	As defined by the CORR program

GENERIC RUN 67
HYDROGEOLOGIC CATEGORY: 9
CHEMICAL: TETRACHLOROETHYLENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	—	0.0013	--	0.0003	0.0054
S	%	Exponential	--	0.717	—	0.5	1.5
B	m	Exponential	—	18	—	7	50
pH		Normal	--	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	--	0.14	--	0.10	0.18
K_a	$\mathrm{mole}^{-1}\mathrm{hr}^{-1}$	--	0	—	—	—	—
K_b	$\mathrm{mole}^{-1}\mathrm{hr}^{-1}$	--	0	—	—	—	—
K_n	hr^{-1}	--	0	—	—	—	—
K_{oc}	ml/g	—	209	—	—	—	—
"ADI"	mg/l	--	6.76×10^{-4}	—	—	—	—
Anaerobic biodegradation	s^{-1}	--	0	--	—	—	—
q	m/yr	Uniform	--	2	--	1	3
α_L under the source	m	Derived from A: $0.05 (\sqrt{A})$	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	--	--	--	0	60

GENERIC RUN 67
HYDROGEOLOGIC CATEGORY: 9
CHEMICAL: TETRACHLOROETHYLENE

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 \ (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} \ (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	--	As defined by the CORR program

GENERIC RUN 68
HYDROGEOLOGIC CATEGORY: 9
CHEMICAL: BENZENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	—	0.0013	—	0.0003	0.0054
S	%	Exponential	—	0.717	—	0.5	1.5
B	m	Exponential	—	18	—	7	50
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.14	—	0.10	0.18
K_a	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_b	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_n	hr^{-1}	—	0	—	—	—	—
K_{oc}	ml/g	—	59	—	—	—	—
"ADI"	mg/l	—	6.63×10^{-4}	—	—	—	—
Anaerobic biodegradation	s^{-1}	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: 0.05 $(\sqrt{A})$	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 68
HYDROGEOLOGIC CATEGORY: 9
CHEMICAL: BENZENE

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	—	As defined by the CORR program

GENERIC RUN 69
HYDROGEOLOGIC CATEGORY: 9
CHEMICAL: 2,4 - DINITROTOLUENE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	--	0.0013	--	0.0003	0.0054
S	%	Exponential	--	0.717	--	0.5	1.5
B	m	Exponential	--	18	--	7	50
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.14	—	0.10	0.18
K_a	$\mathrm{mole}^{-1}\mathrm{hr}^{-1}$	--	0	—	—	—	—
K_b	$\mathrm{mole}^{-1}\mathrm{hr}^{-1}$	--	0	—	—	—	—
K_n	hr^{-1}	--	0	—	—	—	—
K_{oc}	ml/g	—	76	—	—	—	—
"ADI"	mg/l	—	1.13×10^{-4}	—	—	—	—
Anaerobic biodegradation	s^{-1}	—	0	—	—	—	—
q	m/yr	Uniform	--	2	—	1	3
α_L under the source	m	Derived from A: 0.05 ($\sqrt[4]{A}$)	--	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	--	—	—	0	60

GENERIC RUN 69
HYDROGEOLOGIC CATEGORY: 9
CHEMICAL: 2,4 - DINITROTOLUENE

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	--	As defined by the CORR program

GENERIC RUN 70
HYDROGEOLOGIC CATEGORY: 9
CHEMICAL: ARSENIC*

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	--	0.0013	--	0.0003	0.0054
S	%	Exponential	--	0.717	--	0.5	1.5
B	m	Exponential	—	18	--	7	50
pH		Normal	—	7.3	0.6	5.5	9.0
T	$^{\circ}C$	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	--	0.14	—	0.10	0.18
K_a	$mole^{-1}hr^{-1}$	—	0	—	--	—	—
K_b	$mole^{-1}hr^{-1}$	--	0	—	--	—	—
K_n	hr^{-1}	—	0	—	—	—	—
K_{oc}	ml/g	—	0	—	—	—	—
"ADI"	mg/l	--	2.33×10^{-6}	--	—	—	—
Anaerobic biodegradation	s^{-1}	—	0	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: 0.05 ($\sqrt{A}$)	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 70
HYDROGEOLOGIC CATEGORY: 9
CHEMICAL: ARSENIC*

Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9} (X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	--	As defined by the CORR program

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* Note that, since all chemical and biological decay constants are zero for both arsenic and beryllium, one run will cover both chemicals up to the post-processing step (conversion of C_D to concentration at the source).

GENERIC RUN 72
HYDROGEOLOGIC CATEGORY: 9
CHEMICAL: NITRATE

Parameter	Units	Distribution	Single Value	Mean	Standard Deviation	Minimum	Maximum
d	cm	Log_{10} uniform	—	0.0013	—	0.0003	0.0054
S	%	Exponential	—	0.717	—	0.5	1.5
B	m	Exponential	—	18	—	7	50
pH		Normal	—	7.3	0.6	5.5	9.0
T	°C	Normal	—	15	1.65	10	20
FLUXI	m/yr	Uniform	—	0.14	—	0.10	0.18
K_a	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_b	$\text{mole}^{-1}\text{hr}^{-1}$	—	0	—	—	—	—
K_n	hr^{-1}	—	0	—	—	—	—
K_{oc}	ml/g	—	0	—	—	—	—
"ADI"	mg/l	—	3.45	—	—	—	—
Anaerobic biodegradation	s^{-1}	—	3.2×10^{-2}	—	—	—	—
q	m/yr	Uniform	—	2	—	1	3
α_L under the source	m	Derived from A: 0.05 $(\sqrt{A})$	—	—	—	—	—
α_L outside the source	m	Derived from X: 0.1 X	—	—	—	0	60

GENERIC RUN 72
HYDROGEOLOGIC CATEGORY: 9
CHEMICAL: NITRATE

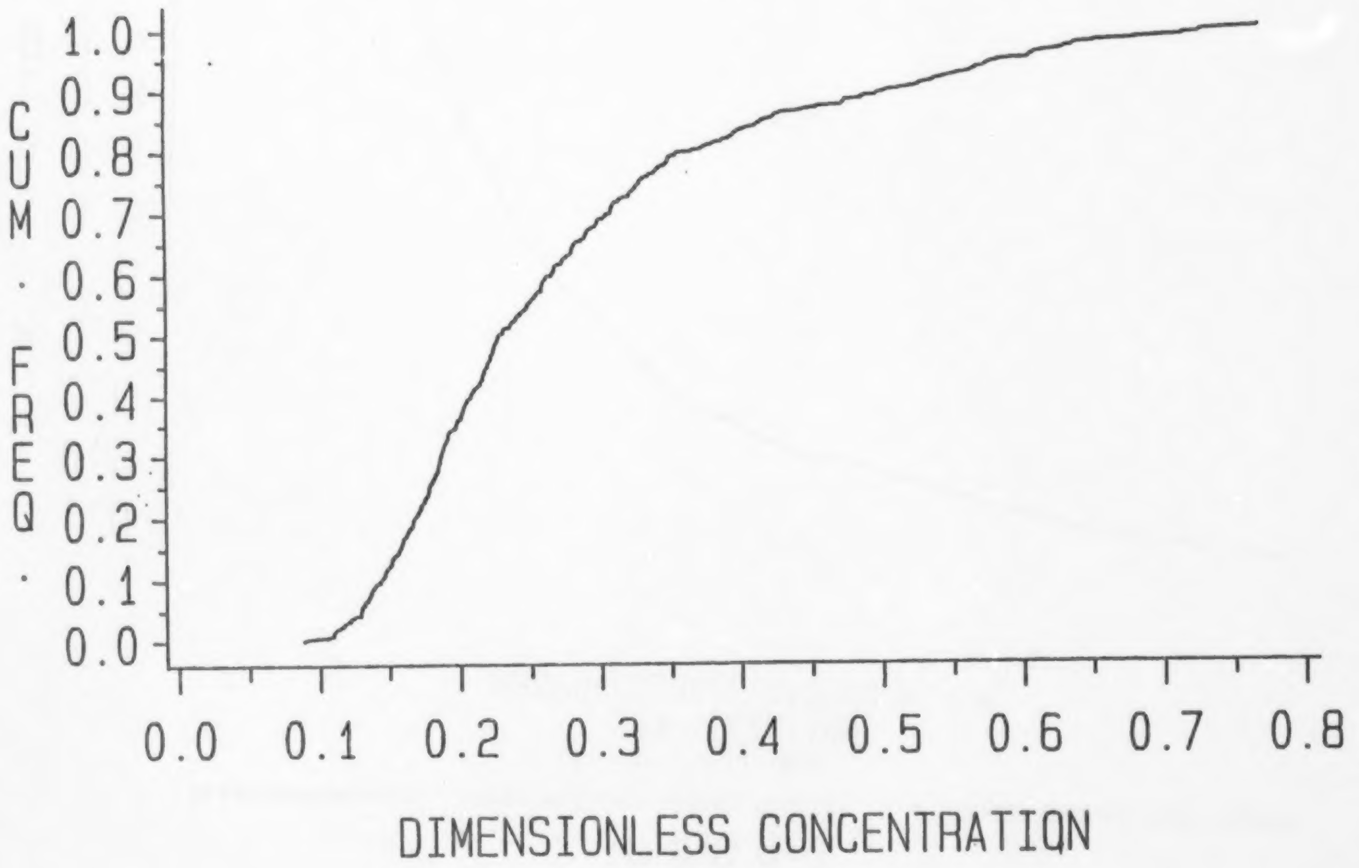
Parameter	Units	Distribution
A	m^2	Defined by $P(A) = 2.36 \times 10^4 (A^{-2.103})$; minimum = 10,522; maximum = 943,760
X	m	Defined by $P(X) = 6.4 \times 10^{-13}(X^3) - 2 \times 10^{-9}(X^2) + 1.22 \times 10^{-6}(X) + 5.84 \times 10^{-4}$; minimum = 35; maximum = 2000
α_z under the source	m	Derived from α_L under the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range of 0.025 to 0.10
α_z outside the source	m	Derived from α_L outside the source: $\alpha_z = c\alpha_L$; where c is an uniform distribution over the range 0.025 to 0.10
f_{oc}	--	As defined by the CORR program

APPENDIX 4.5

RESULTS OF GENERIC RUNS: DIMENSIONLESS CONCENTRATIONS

RUN 1

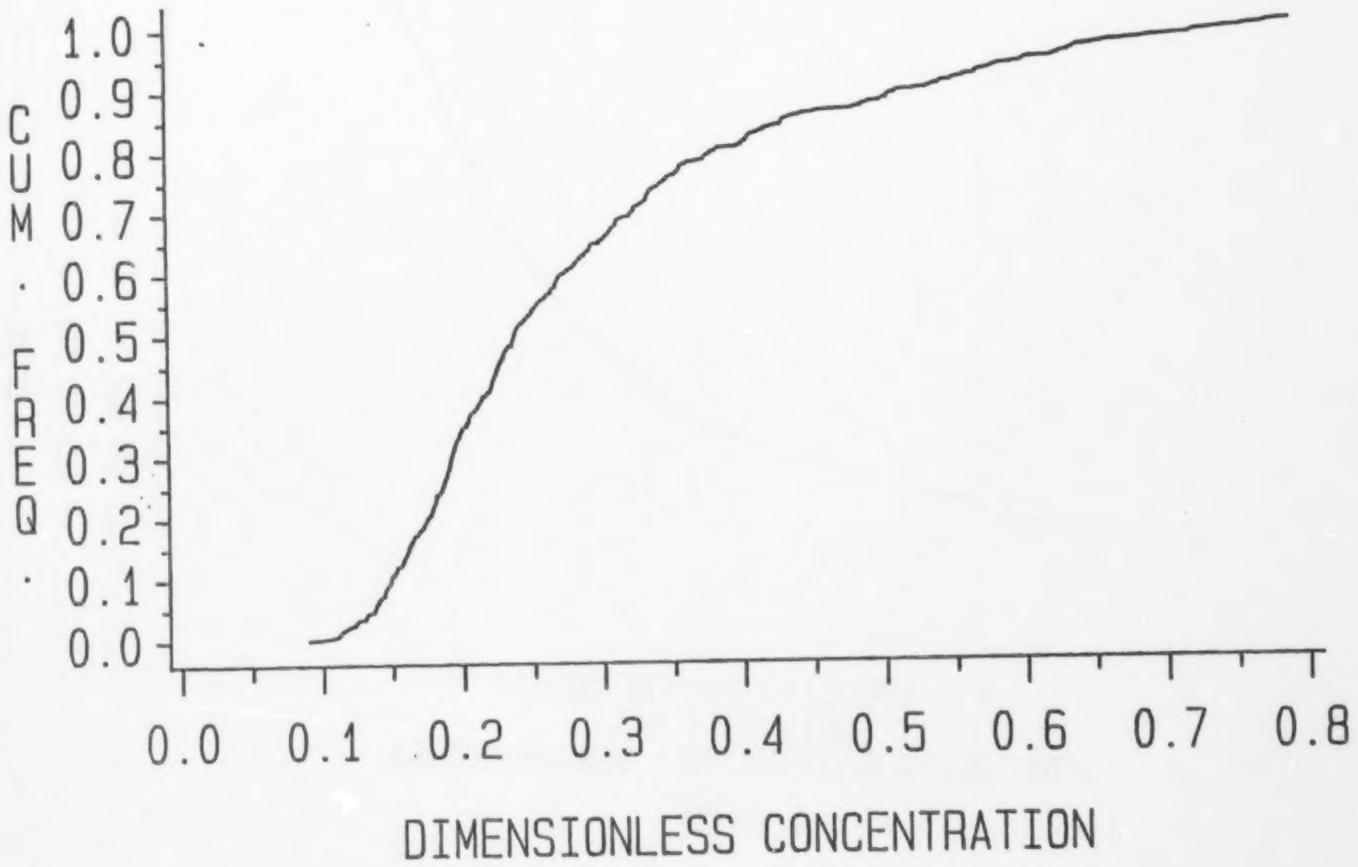
CHLOROFORM – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY - 4



RUNS 2–6

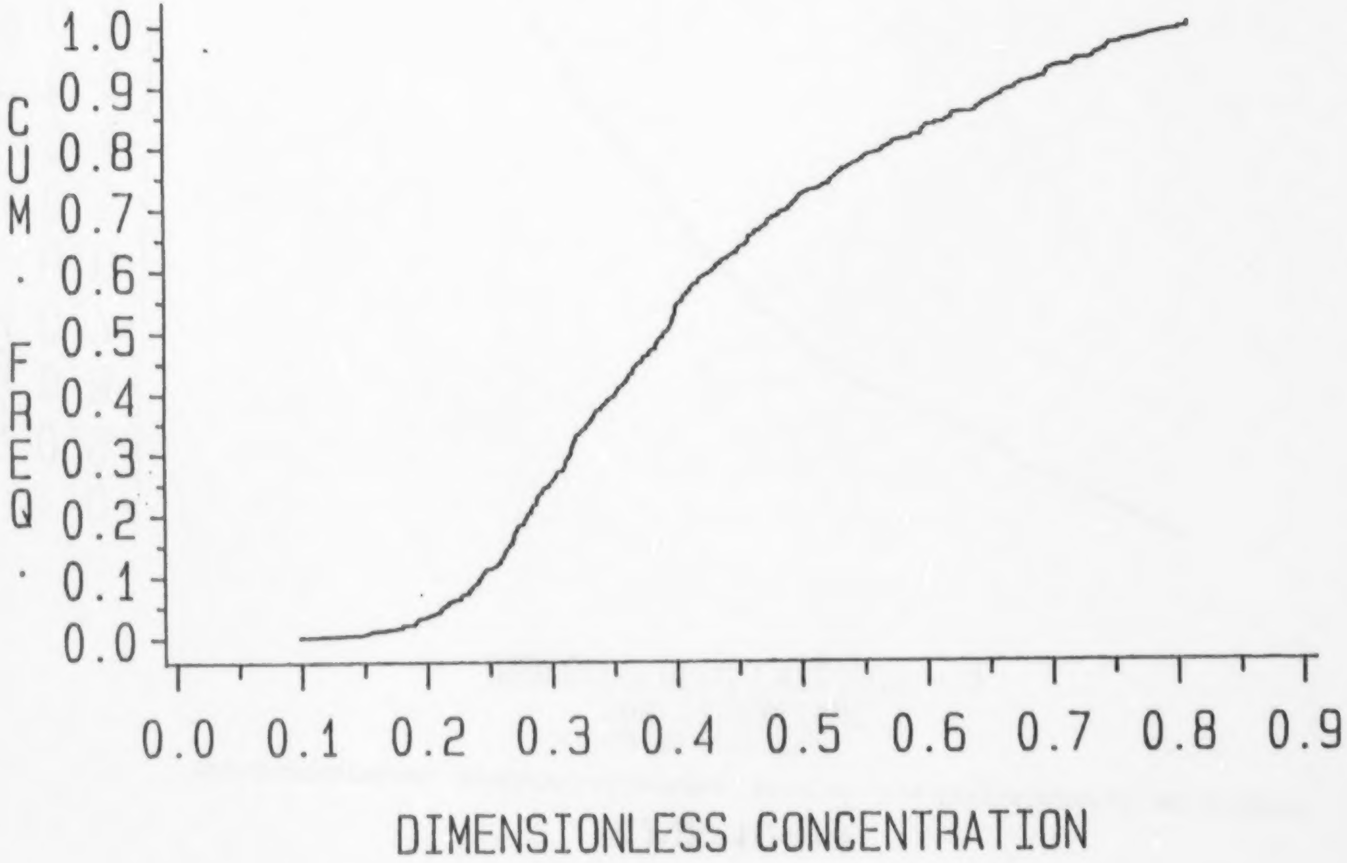
HEXACHLOROBENZENE, TETRACHLOROETHYLENE, BENZENE, 2,4-DINITROTOLUENE AND ARSENIC

SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY - 4



RUN 9

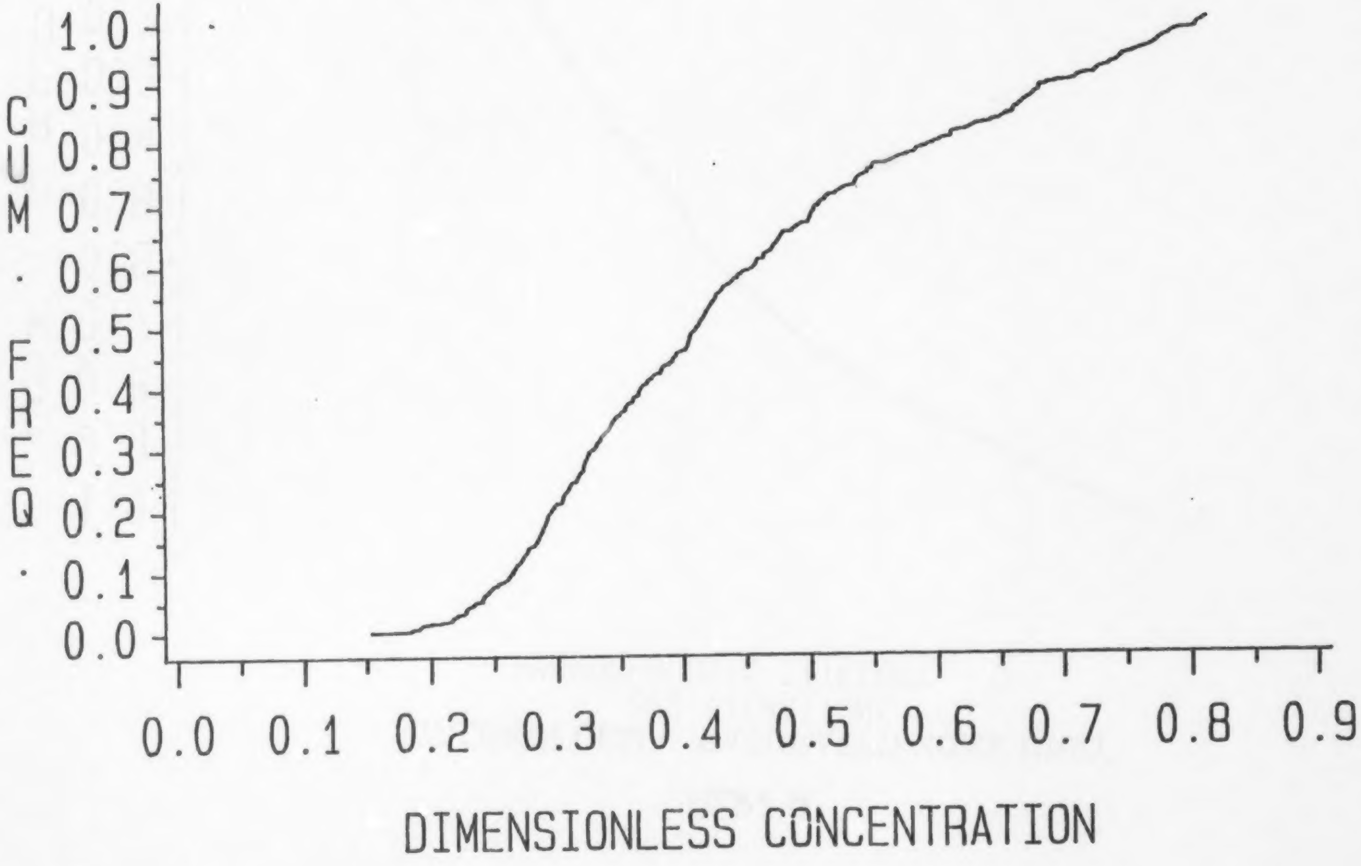
CHLOROFORM – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY - 5



RUNS 10–14

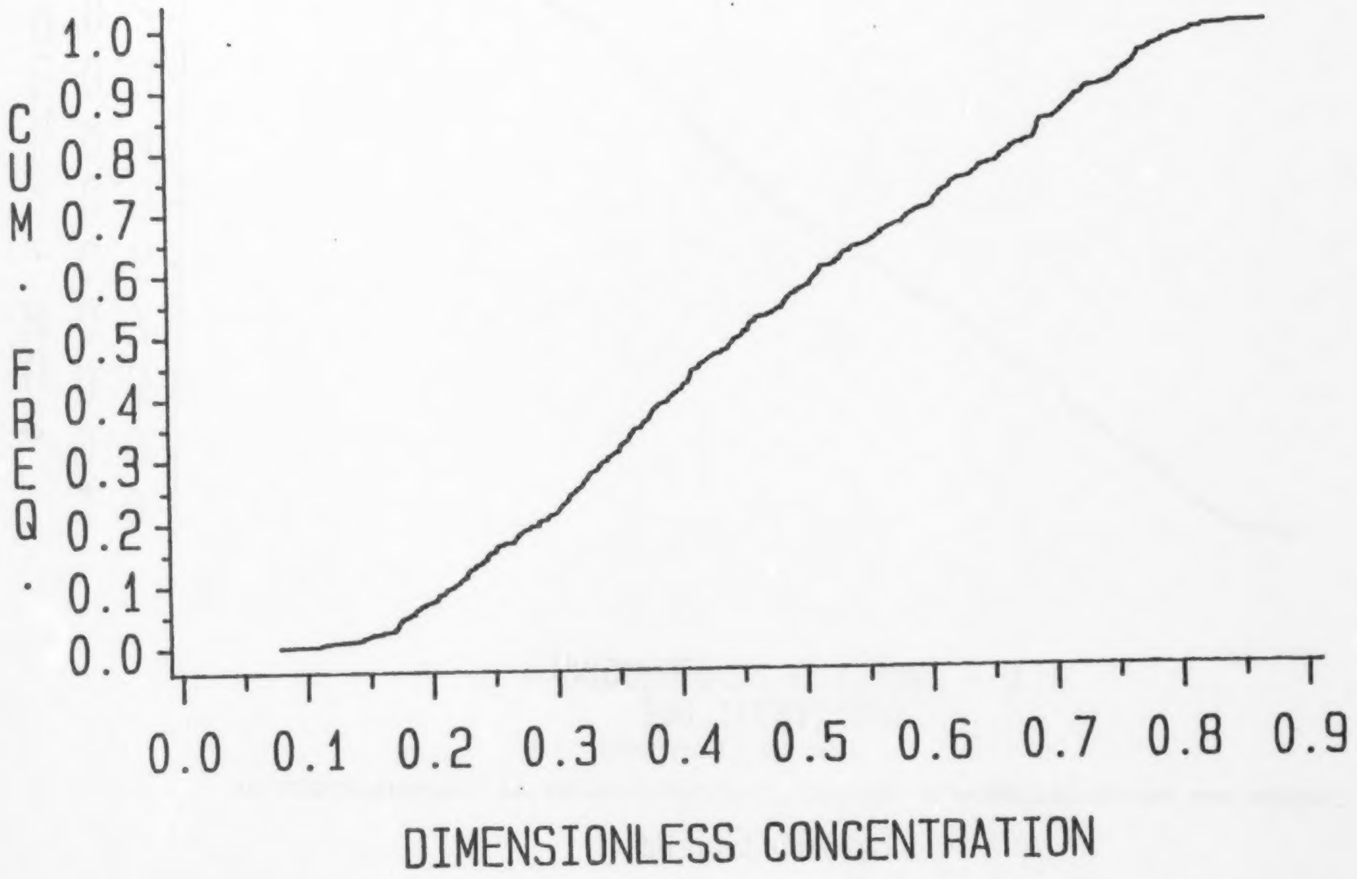
HEXACHLOROBENZENE, TETRACHLOROETHYLENE, BENZENE, 2,4-DINITROTOLUENE AND ARSENIC

SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY - 5



RUN 17

CHLOROFORM – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY – 1



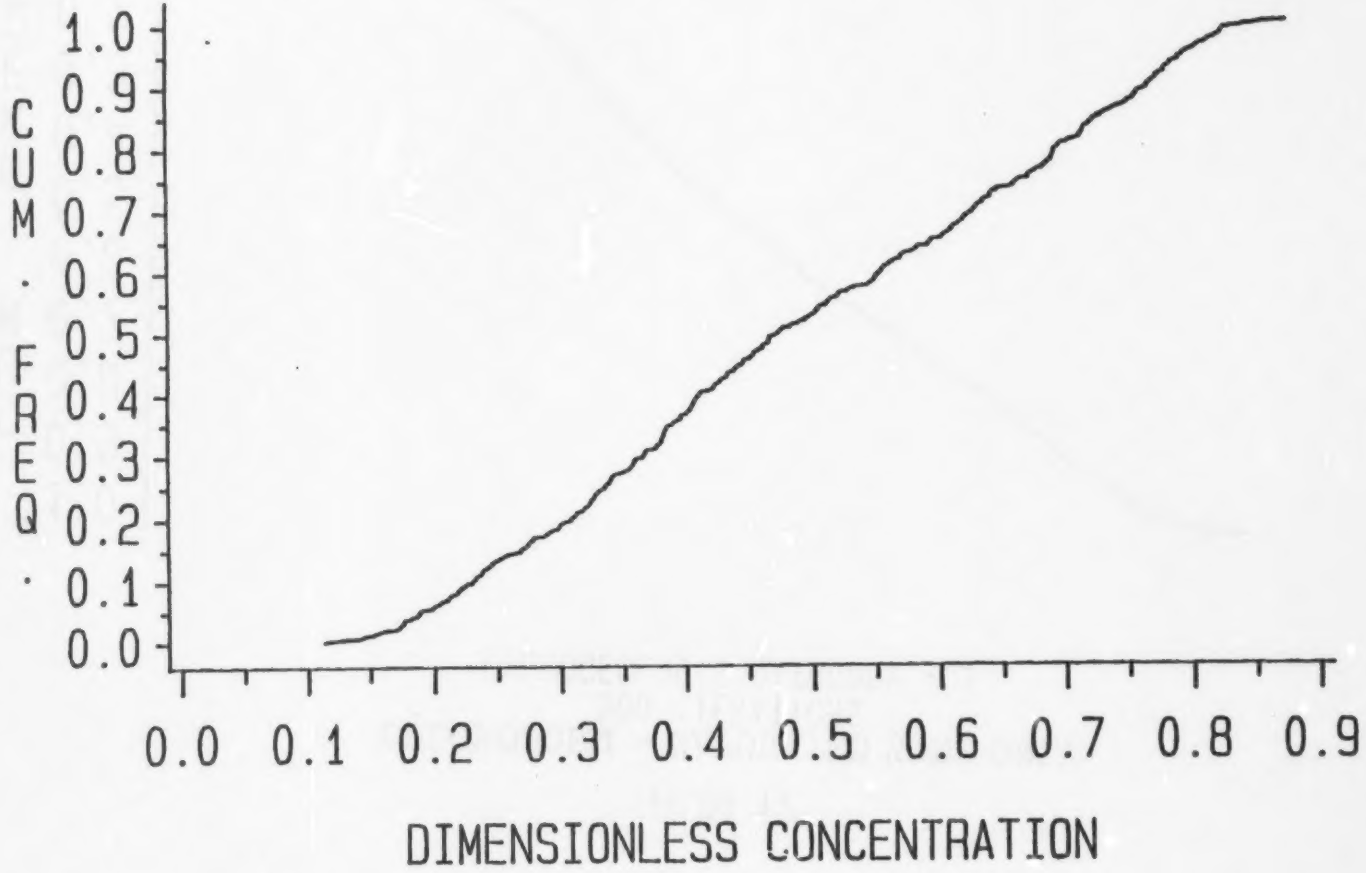
RUNS 18–22

HEXACHLOROBENZENE, TETRACHLOROETHYLENE, BENZENE, 2,4-DINITROTOLUENE AND ARSENIC

SATURATED ZONE ONLY

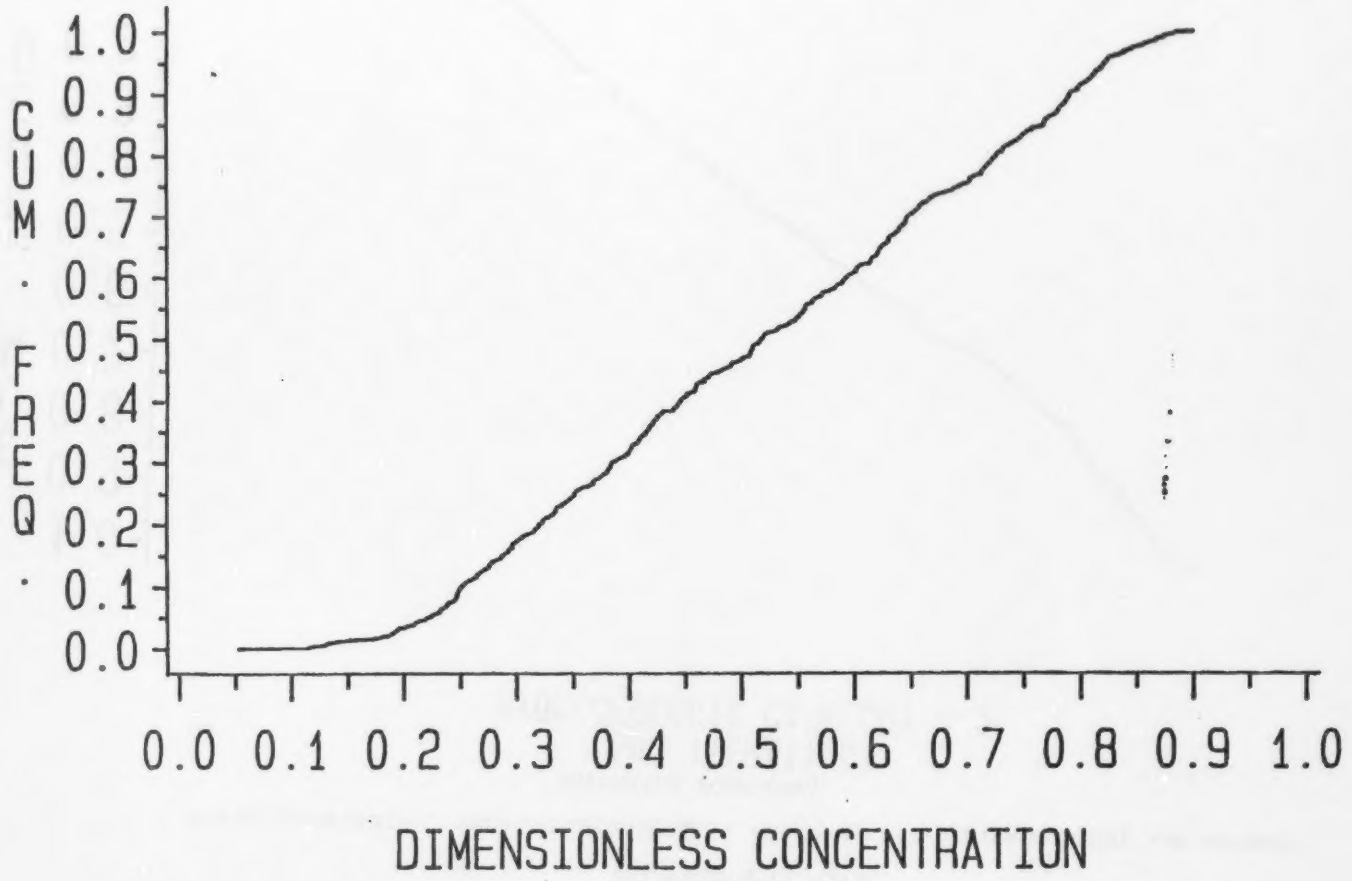
500 ITERATIONS

HYDROGEOLOGIC CATEGORY – 1



RUN 25

CHLOROFORM – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY - 2



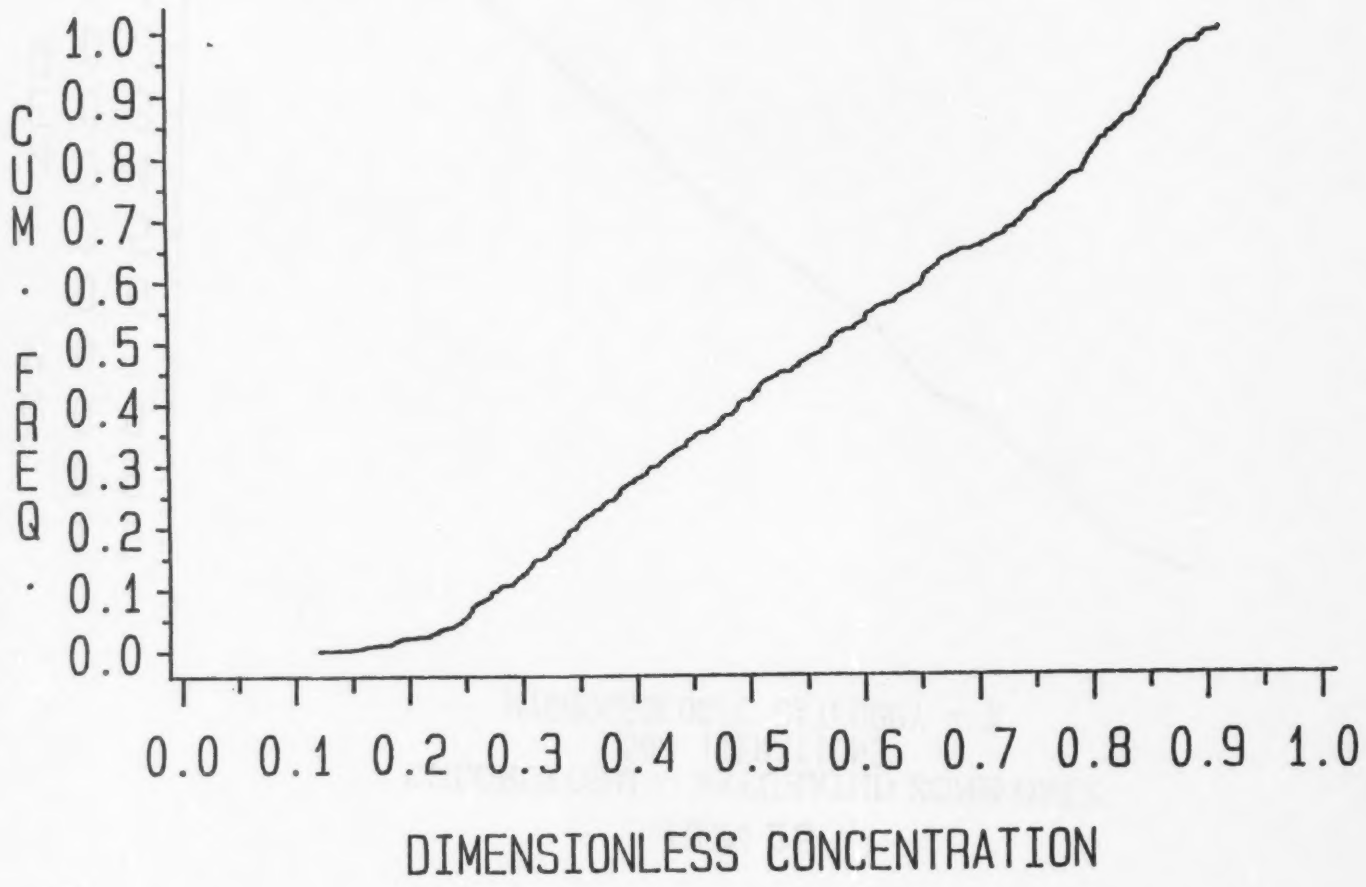
RUNS 26–30

HEXACHLOROBENZENE, TETRACHLOROETHYLENE, BENZENE, 2,4-DINITROTOLUENE AND ARSENIC.

SATURATED ZONE ONLY

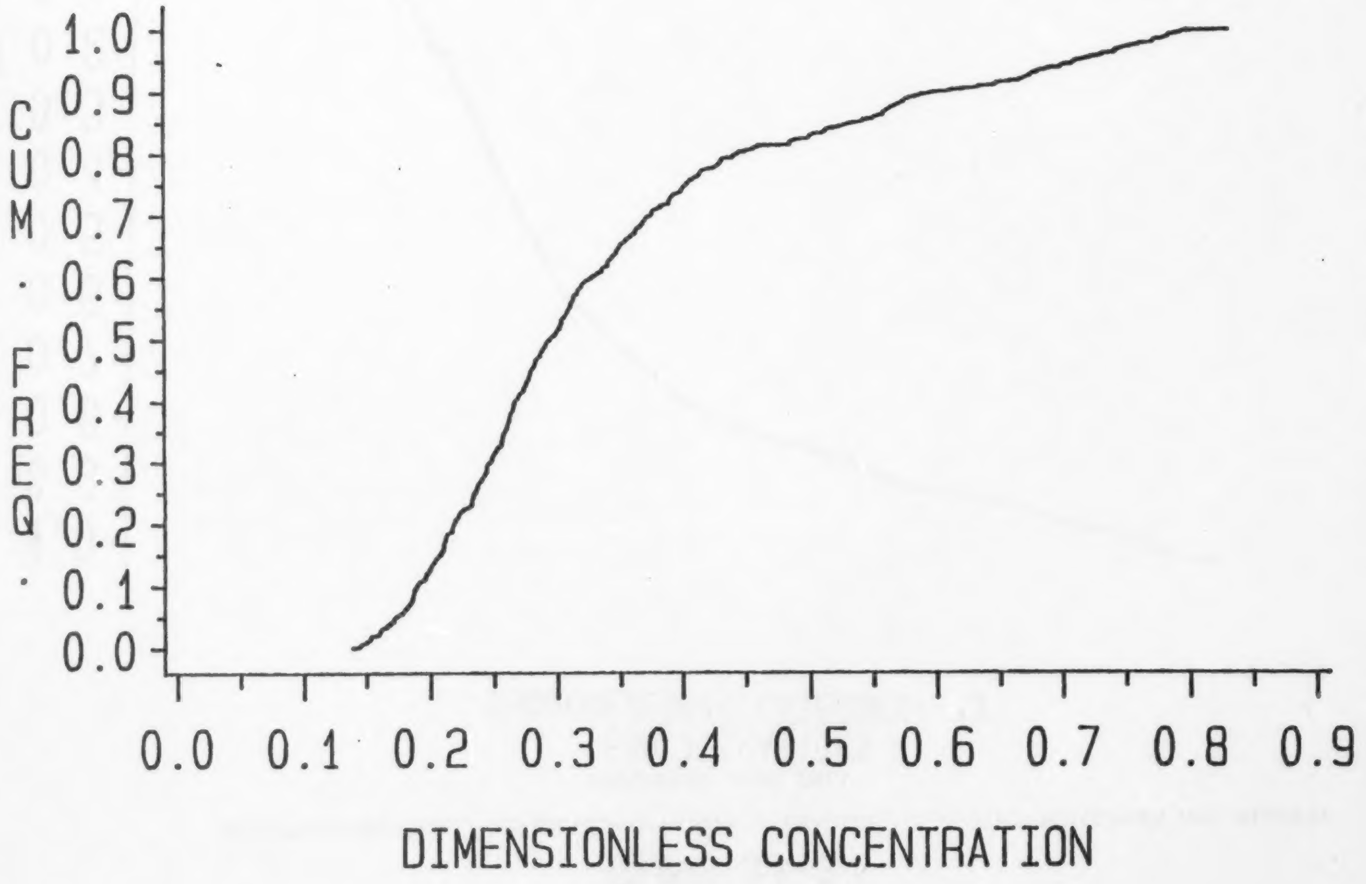
500 ITERATIONS

HYDROGEOLOGIC CATEGORY - 2



RUN 33

CHLOROFORM – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY - 3



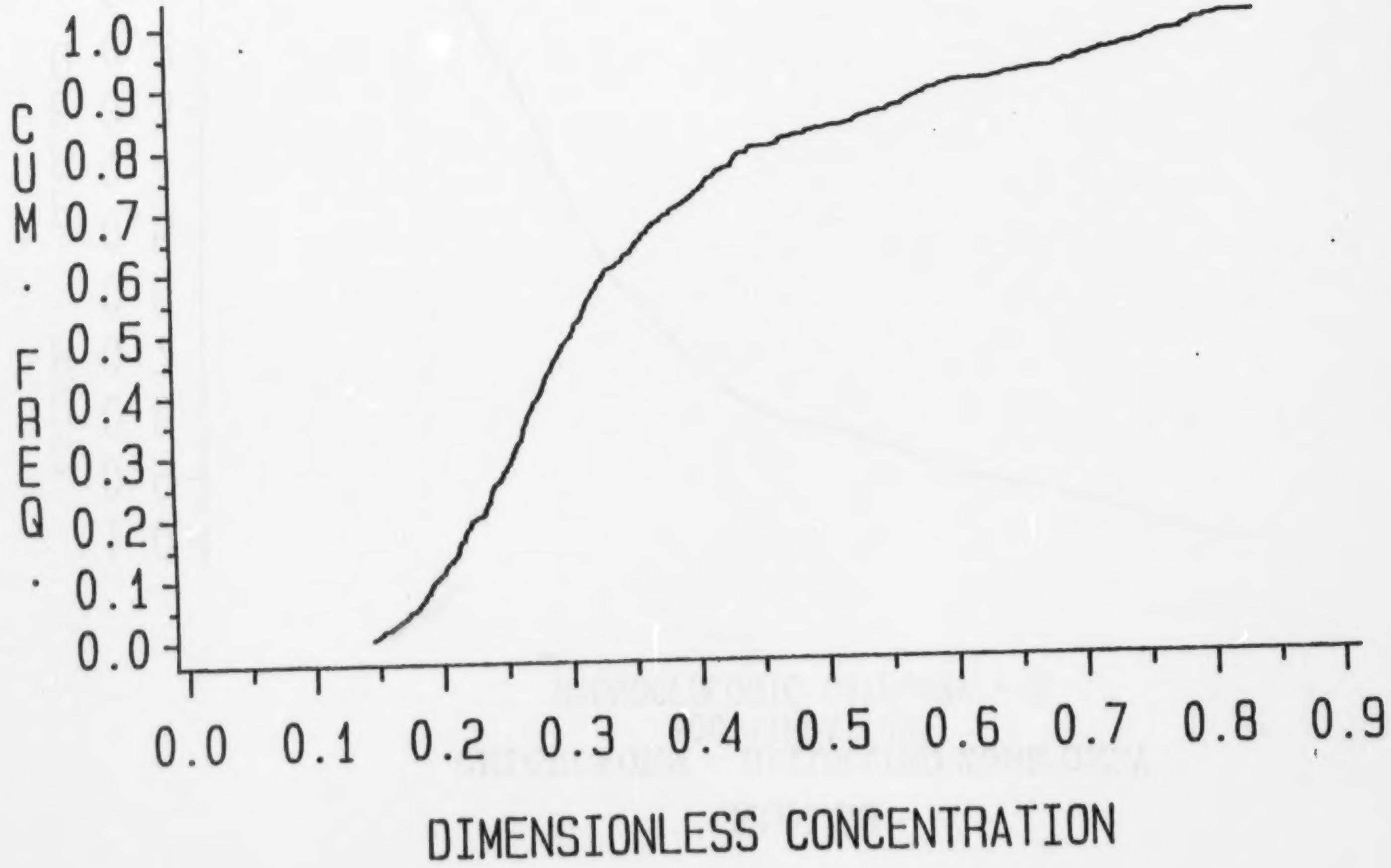
RUNS 34-38

HEXACHLOROBENZENE, TETRACHLOROETHYLENE, BENZENE, 2,4-DINITROTOLUENE AND ARSENIC

SATURATED ZONE ONLY

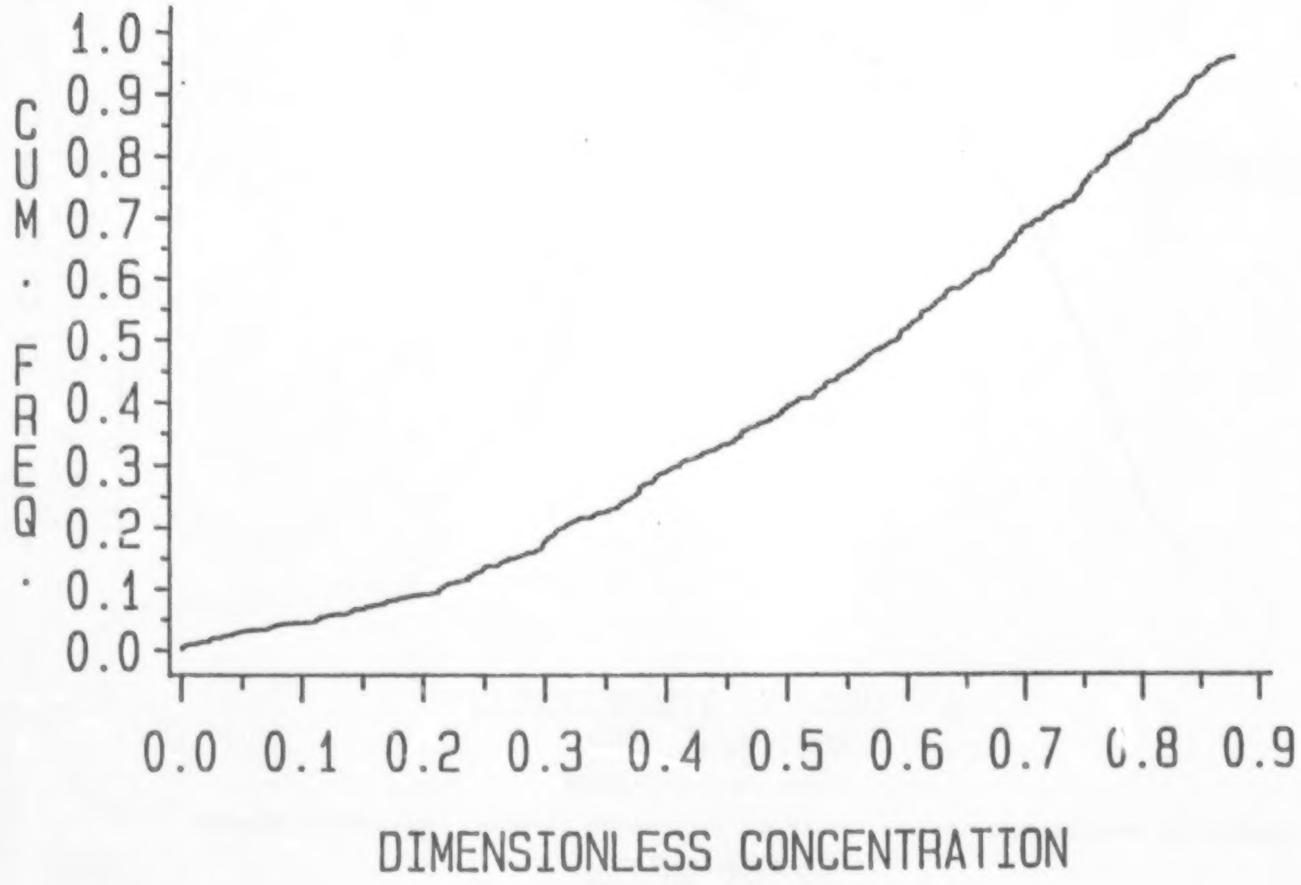
500 ITERATIONS

HYDROGEOLOGIC CATEGORY - 3



RUN 41

CHLOROFORM – SATURATED ZONE ONLY
493 ITERATIONS
HYDROGEOLOGIC CATEGORY - 6

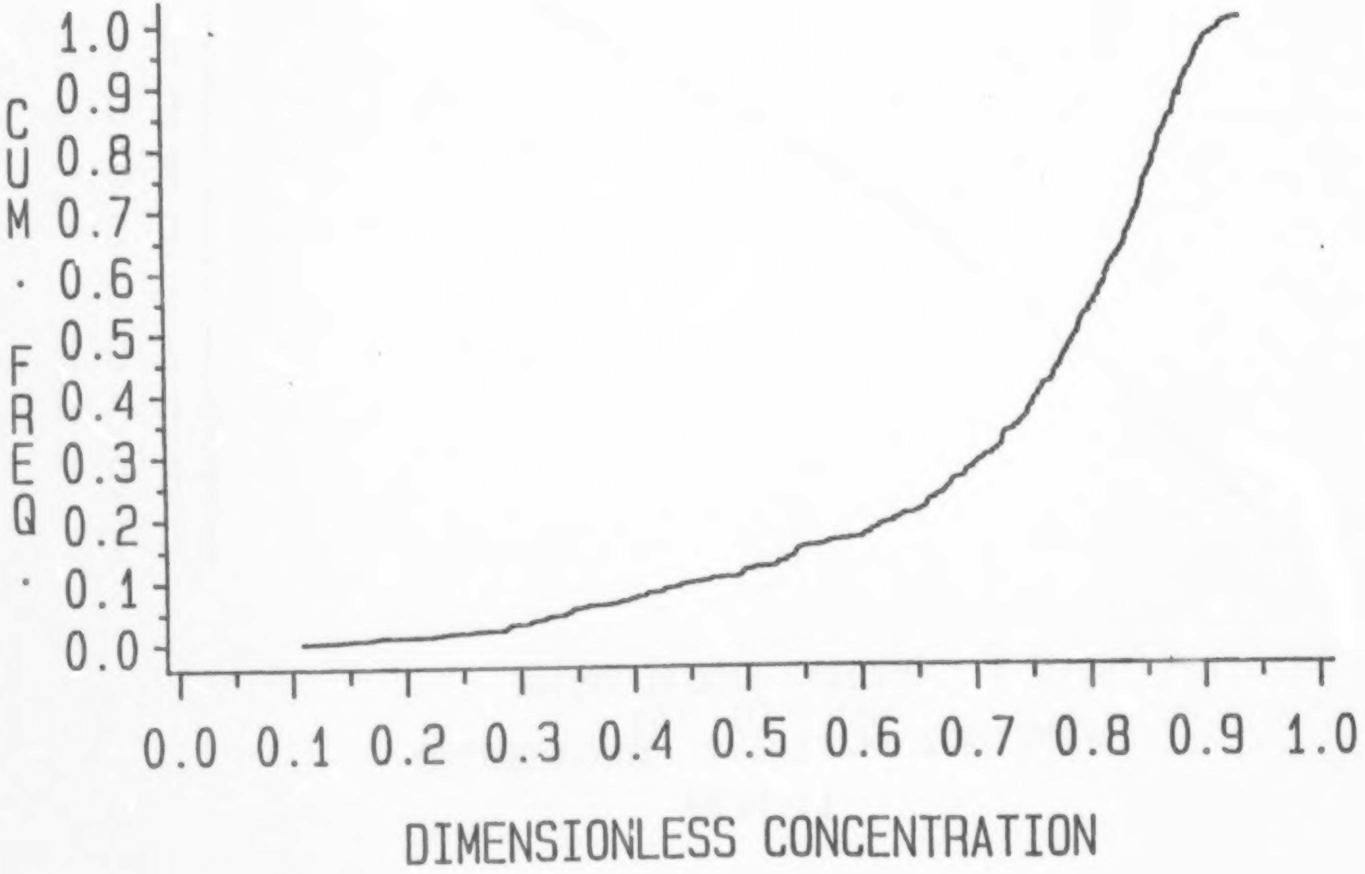


RUNS 42-46

HEXACHLOROBENZENE, TETRACHLOROETHYLENE, BENZENE, 2,4-DINITROTOLUENE AND ARSENIC

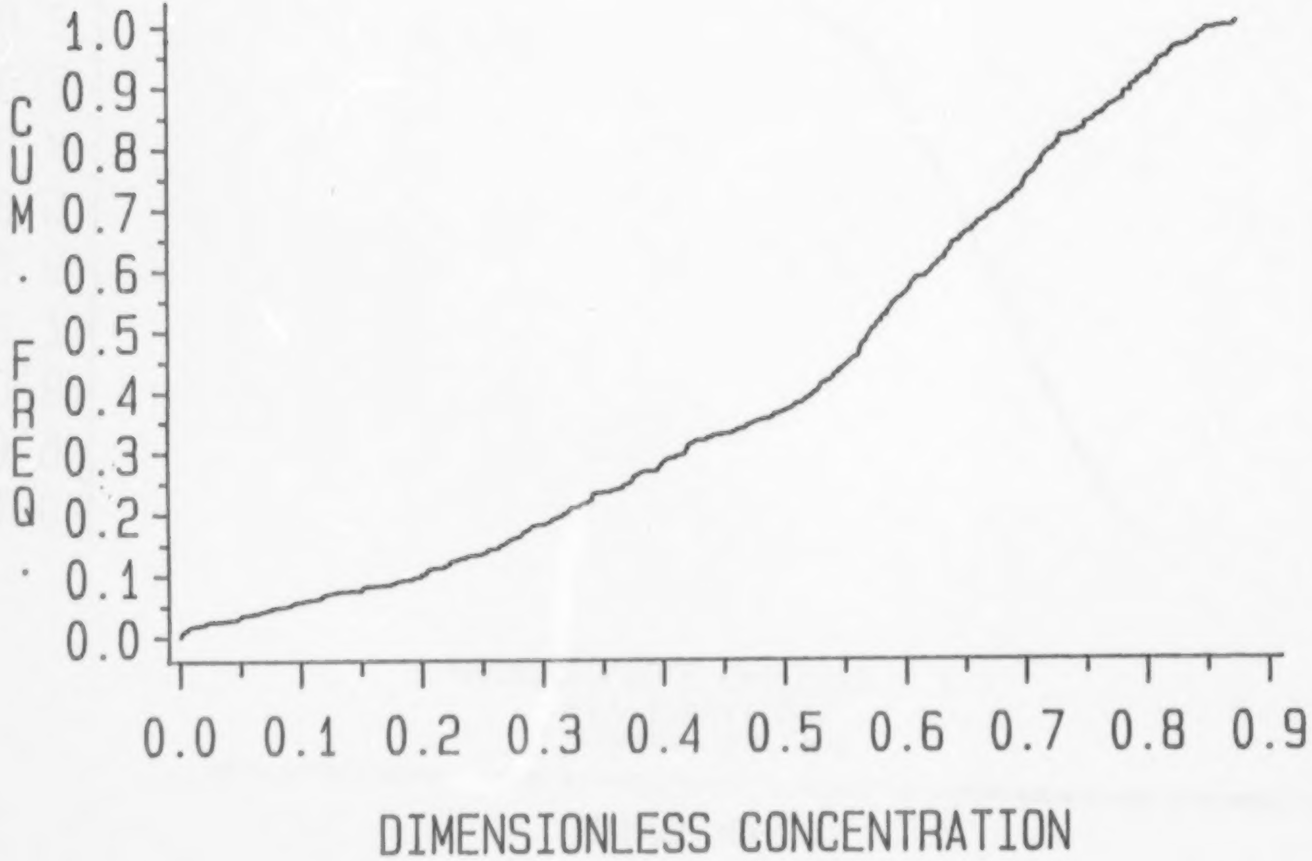
SATURATED ZONE ONLY

493 ITERATIONS
HYDROGEOLOGIC CATEGORY - 6



RUN 49

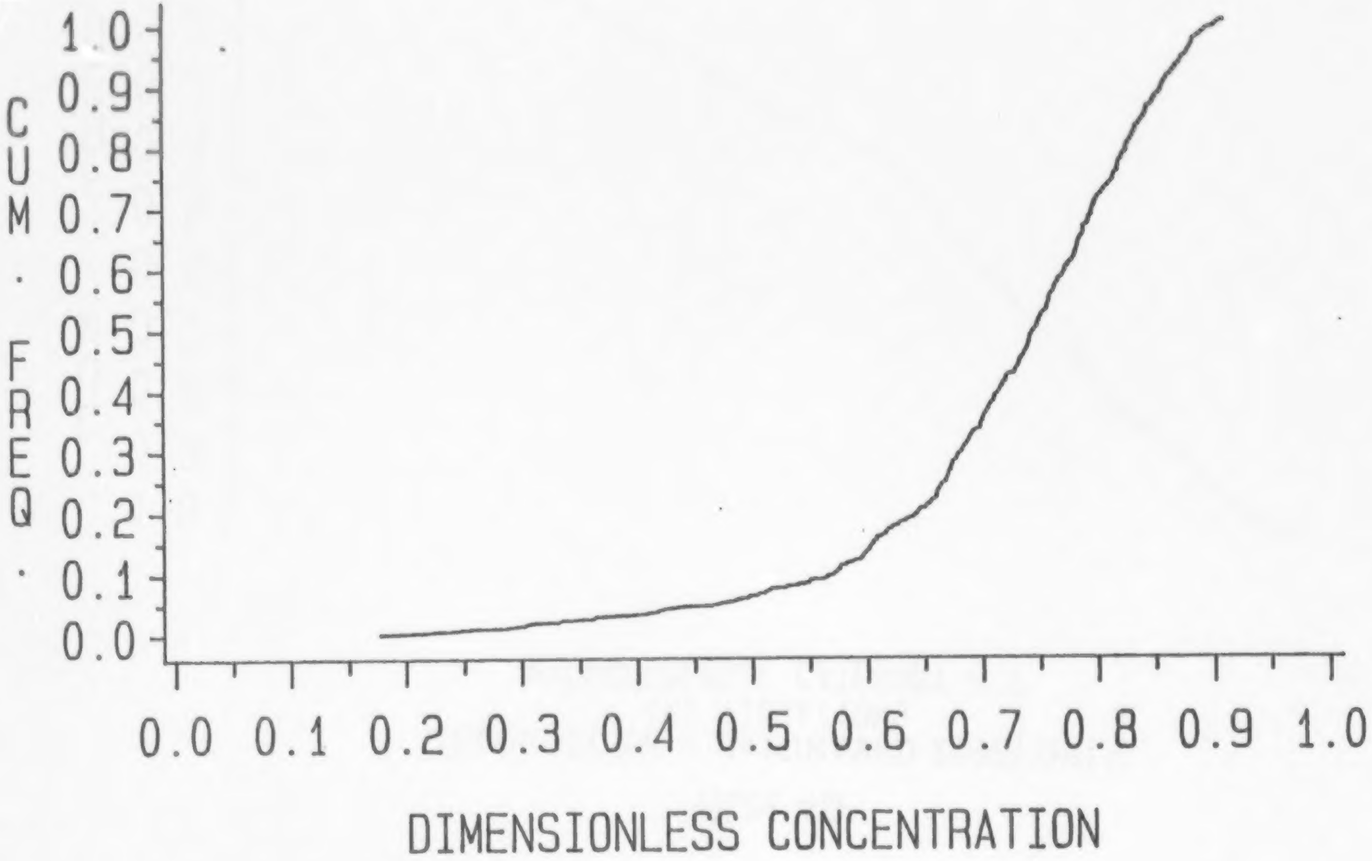
CHLOROFORM – SATURATED ZONE ONLY
497 ITERATIONS
HYDROGEOLOGIC CATEGORY – 7



RUNS 50–54

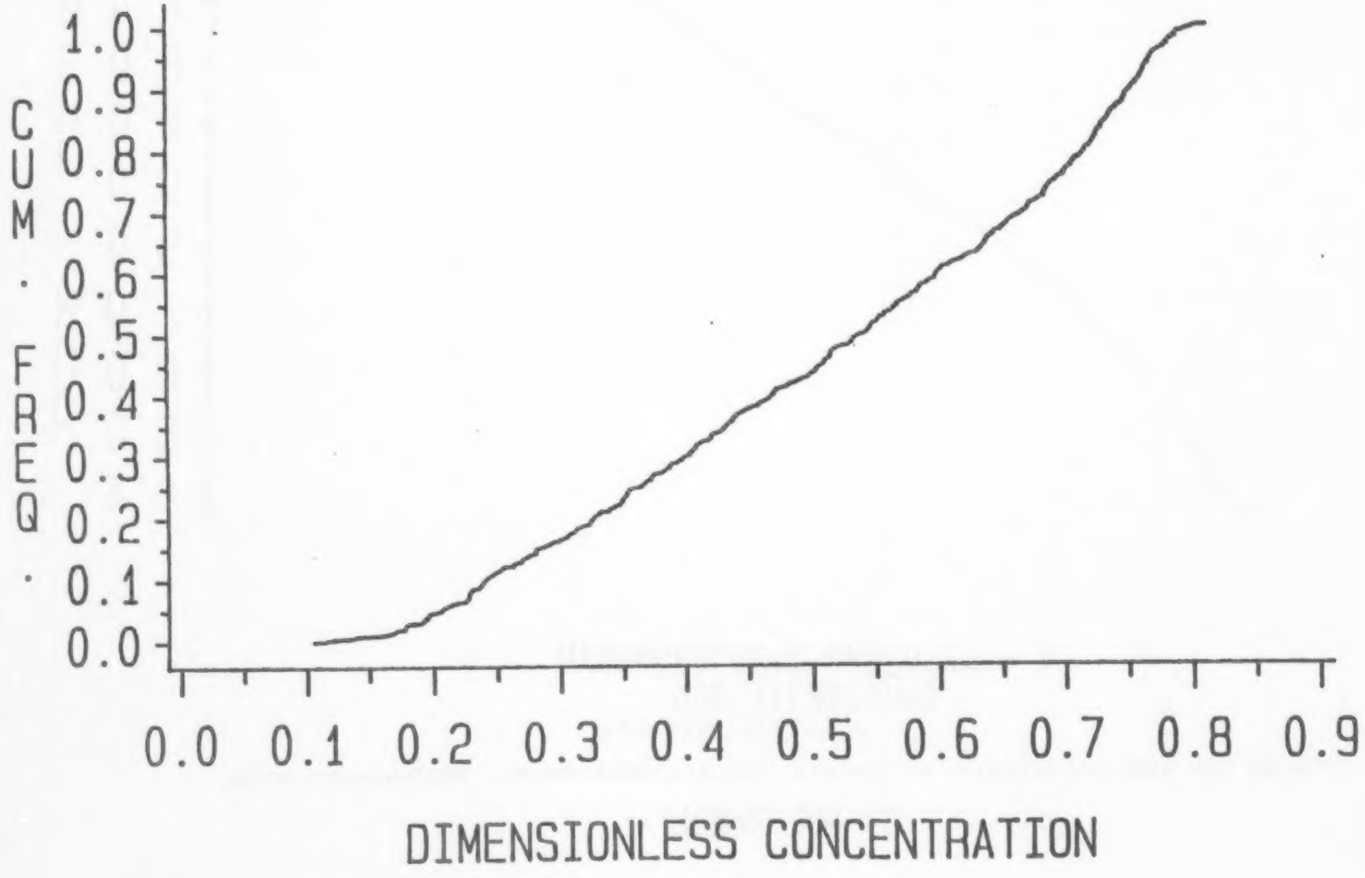
HEXACHLOROBENZENE, TETRACHLOROETHYLENE, BENZENE, 2,4-DINITROTOLUENE AND ARSENIC

SATURATED ZONE ONLY
497 ITERATIONS
HYDROGEOLOGIC CATEGORY - 7



RUN 57

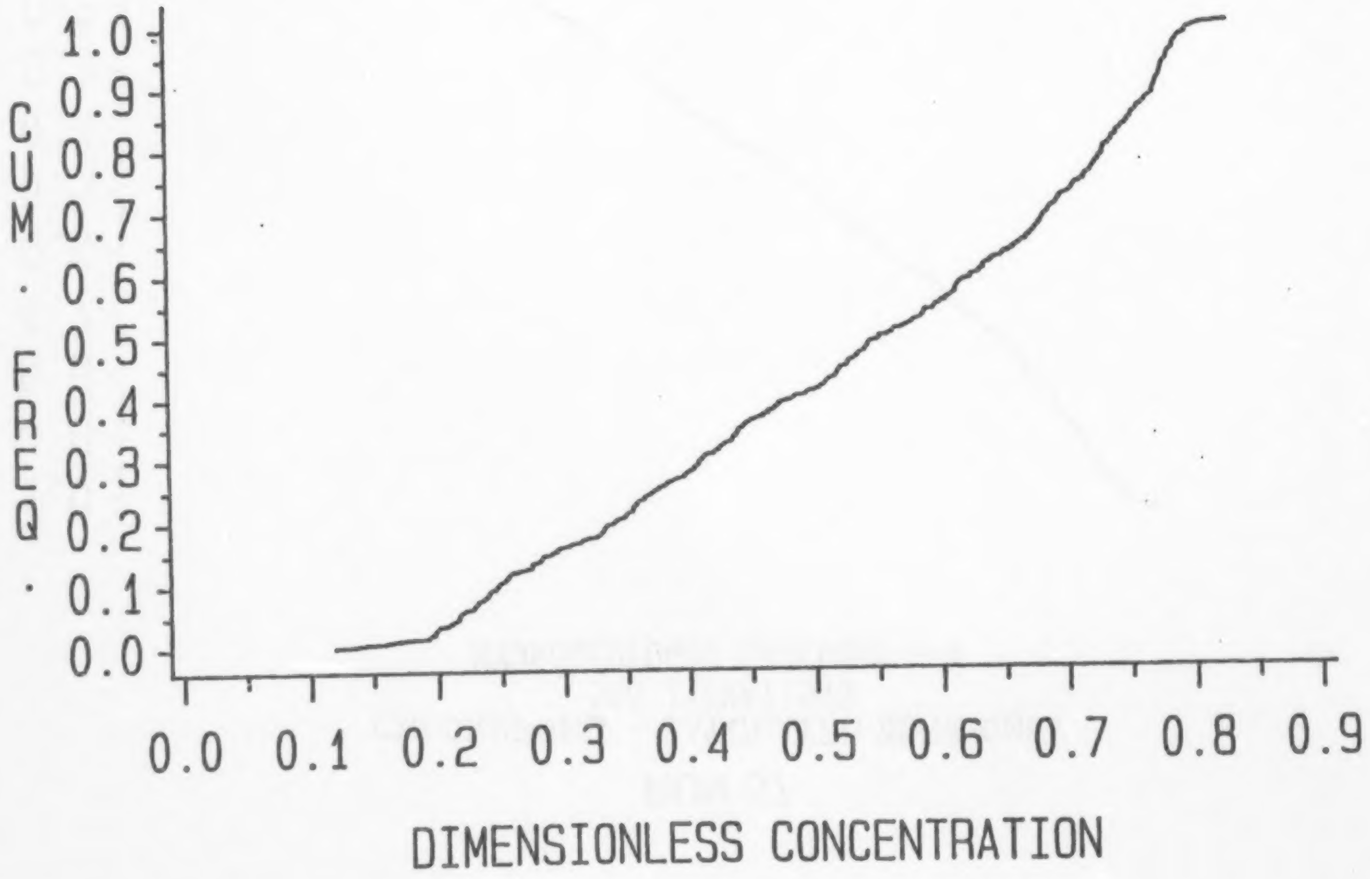
CHLOROFORM – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY – 8



RUNS 58-62

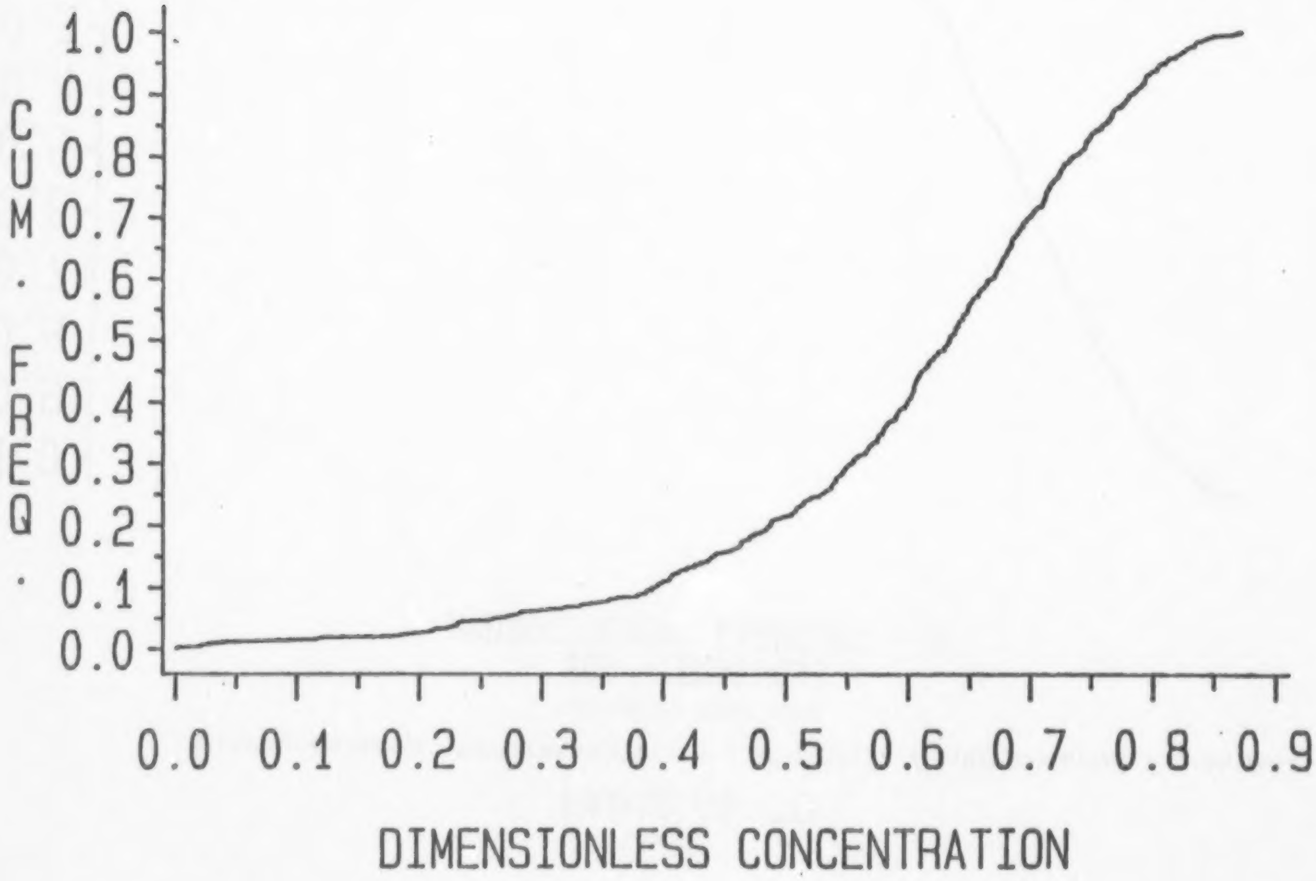
HEXACHLOROBENZENE, TETRACHLOROETHYLENE, BENZENE, 2,4-DINITROTOLUENE AND ARSENIC

SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY - 8



RUN 65

CHLOROFORM – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY – 9

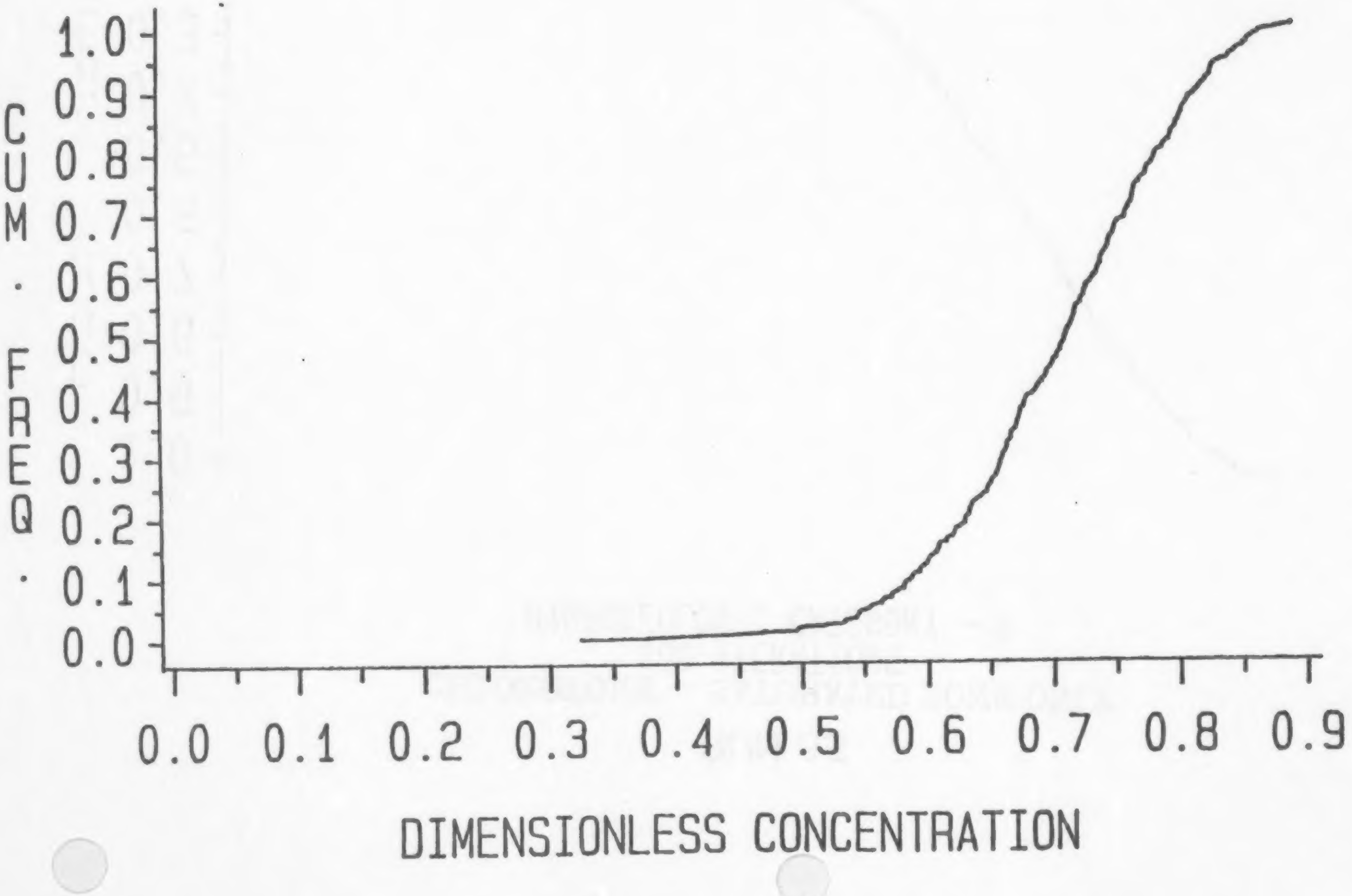


RUNS 66–70

HEXACHLOROBENZENE, TETRACHLOROETHYLENE, BENZENE, 2,4-DINITROTOLUENE AND ARSENIC

SATURATED ZONE ONLY

500 ITERATIONS
HYDROGEOLOGIC CATEGORY – 9

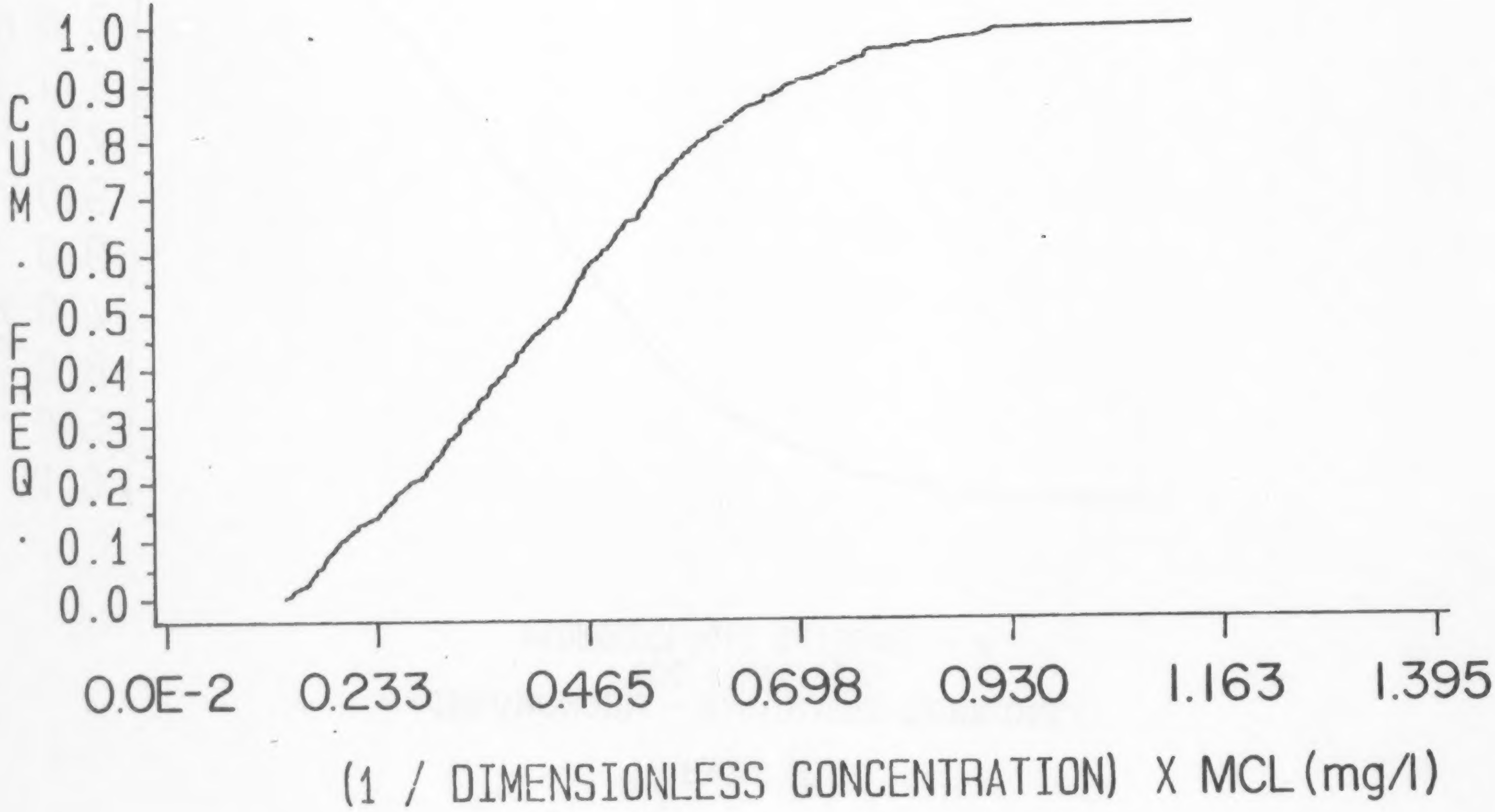


APPENDIX 4.6

RESULTS OF GENERIC RUNS: TARGET LAGOON CONCENTRATIONS BASED ON HUMAN HEALTH THRESHOLDS

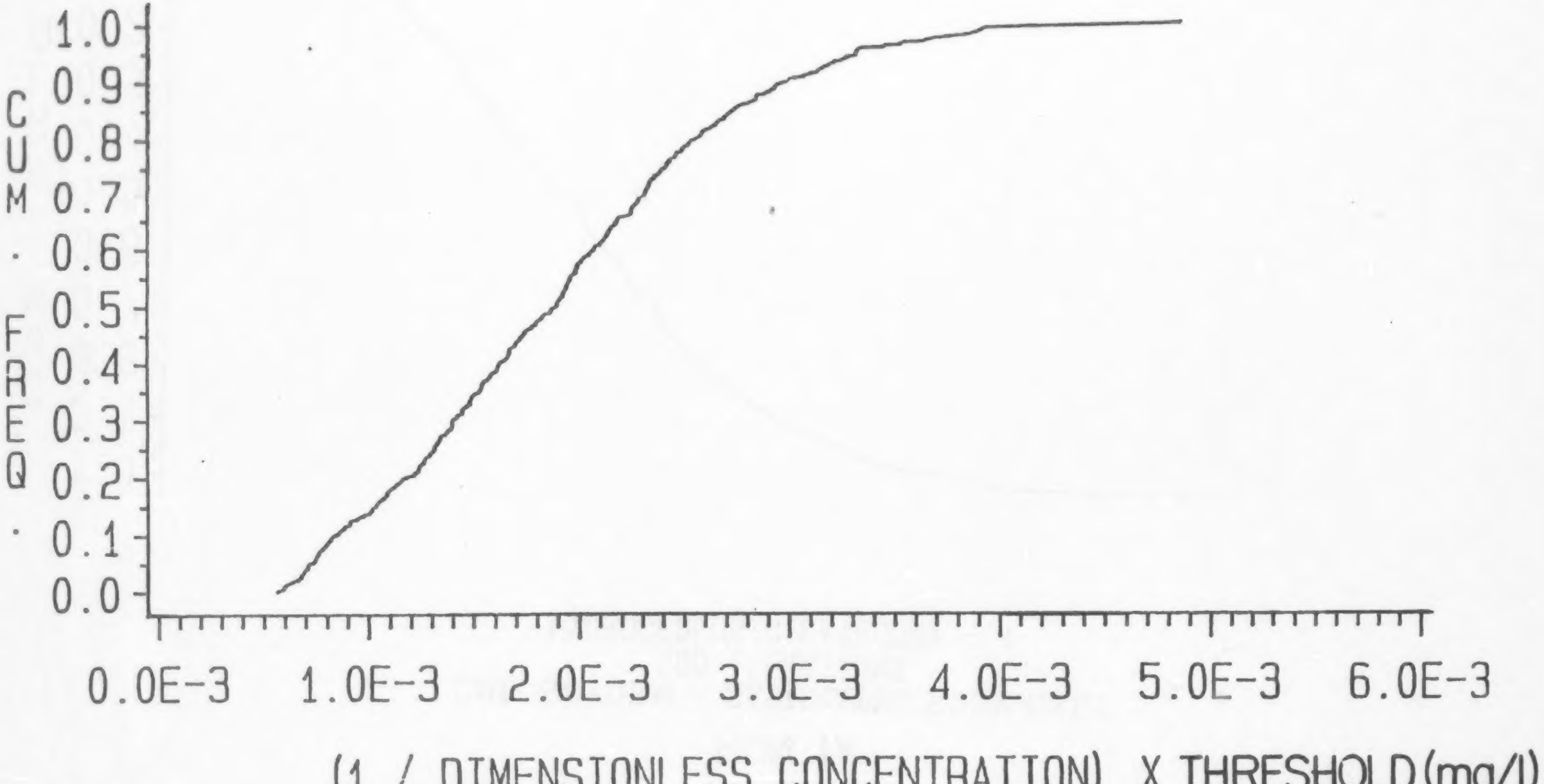
RUN 1A

CHLOROFORM – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY – 4



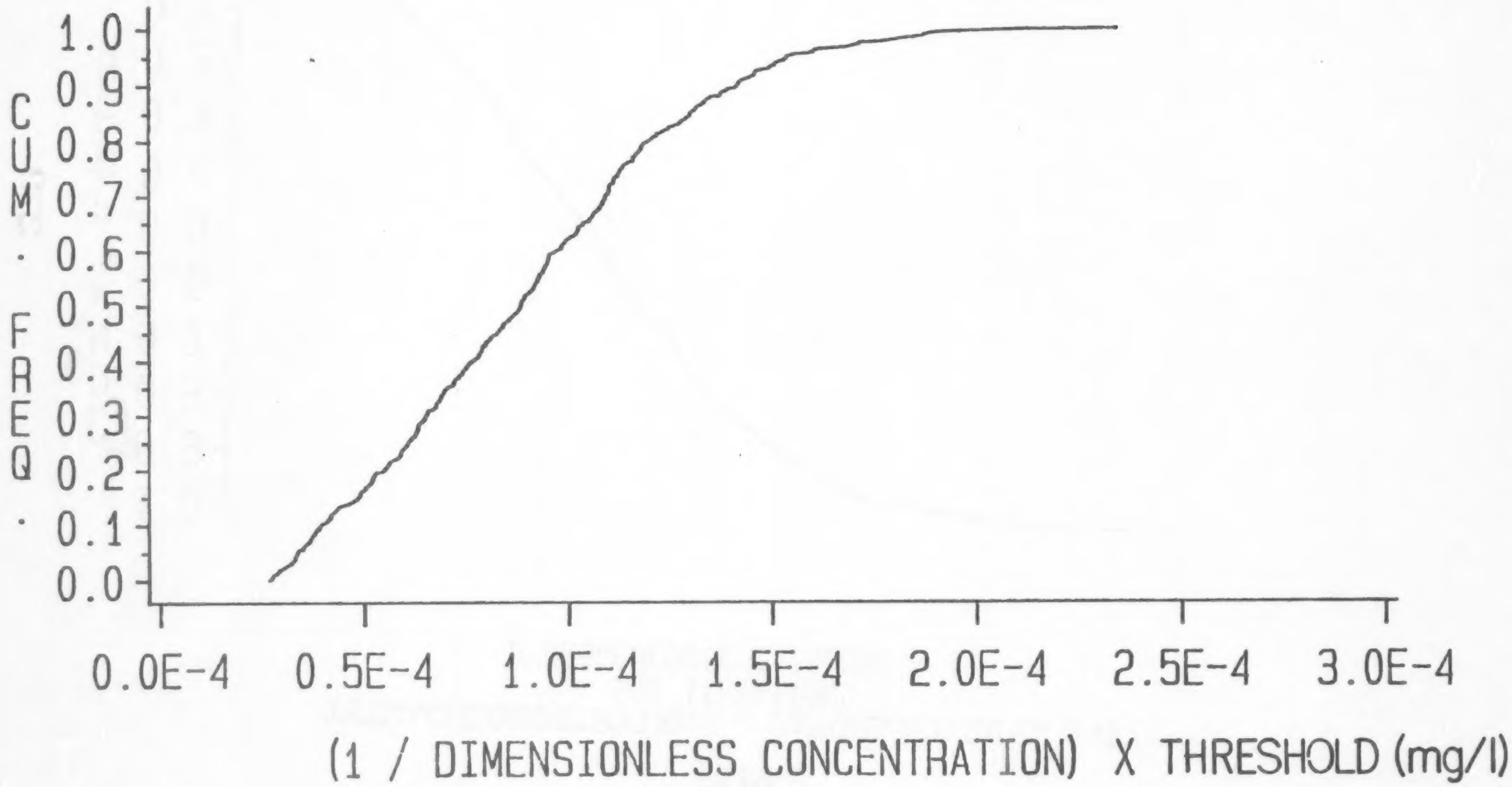
RUN 1B

CHLOROFORM – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY - 4



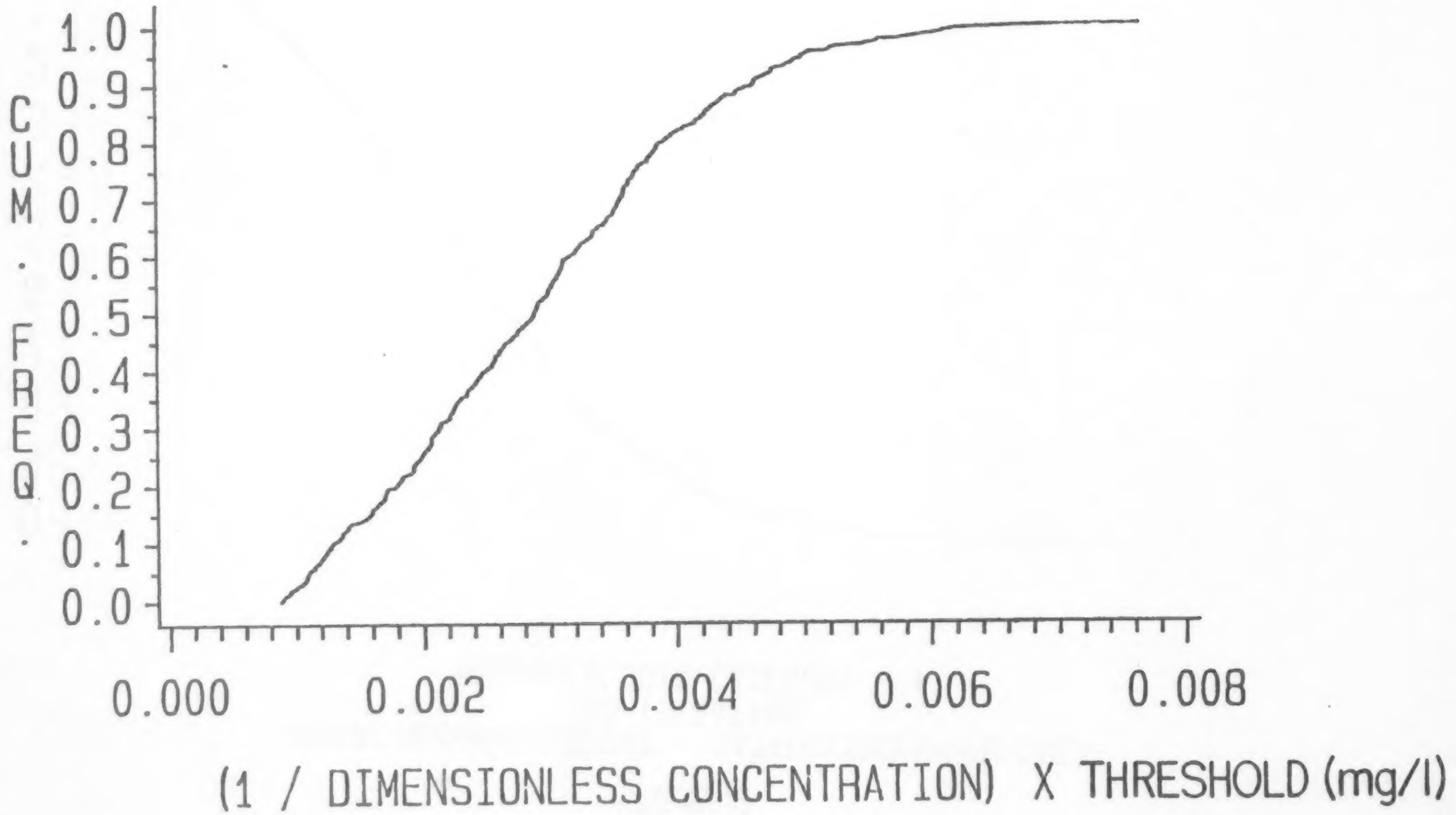
RUN 2

HEXACHLOROBENZENE – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY - 4



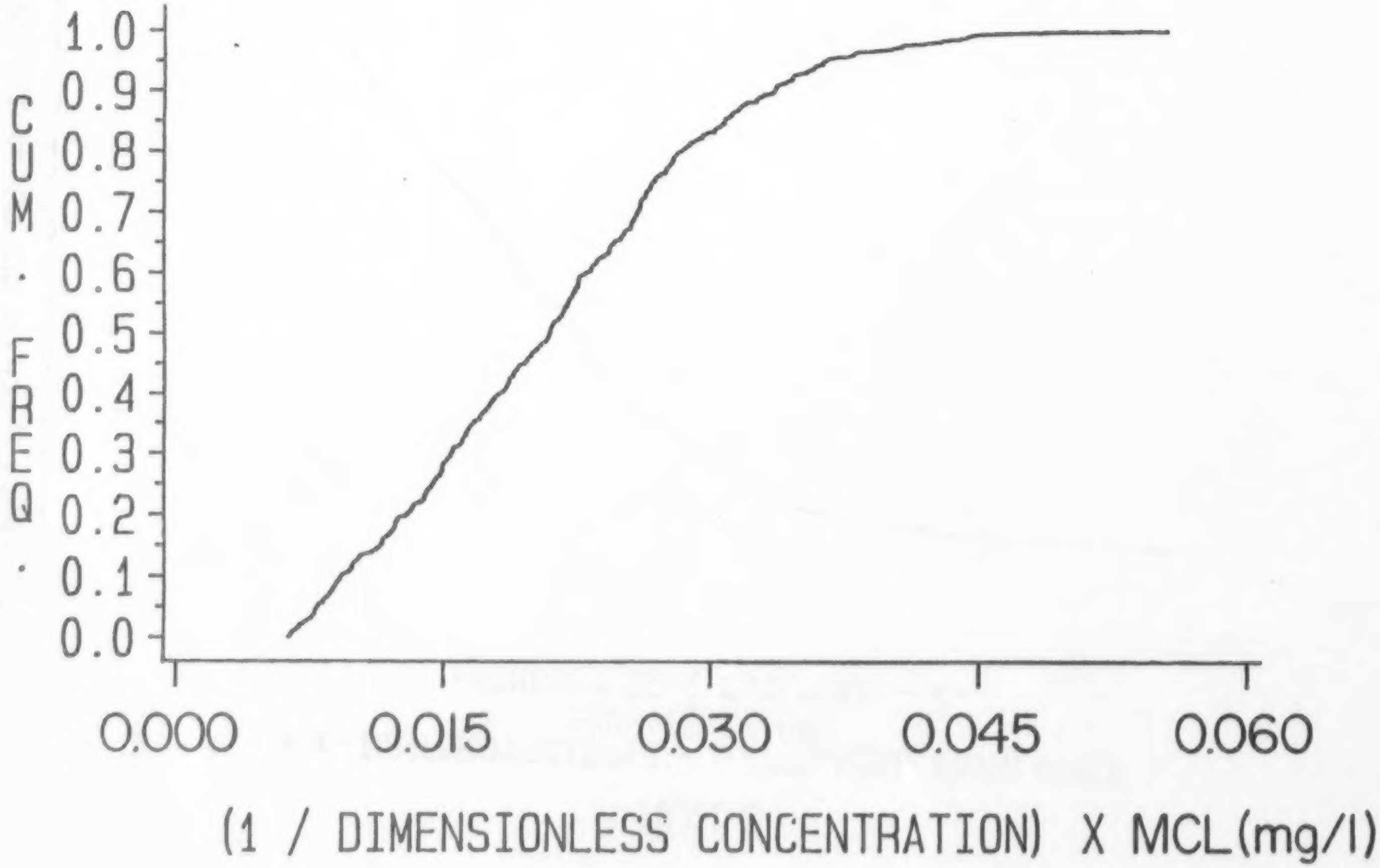
RUN 3

TETRACHLOROETHYLENE – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY - 4



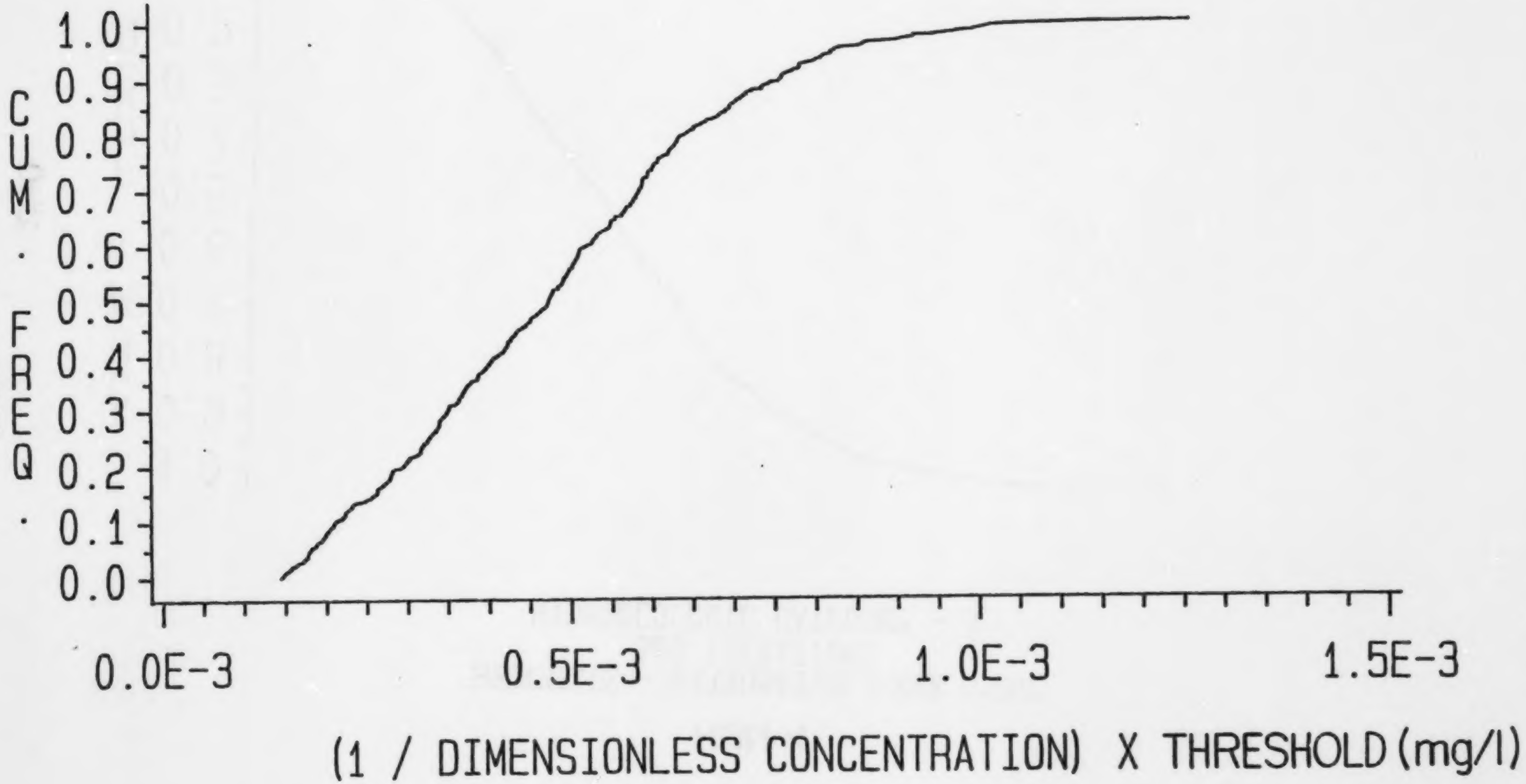
RUN 4

BENZENE – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY – 4



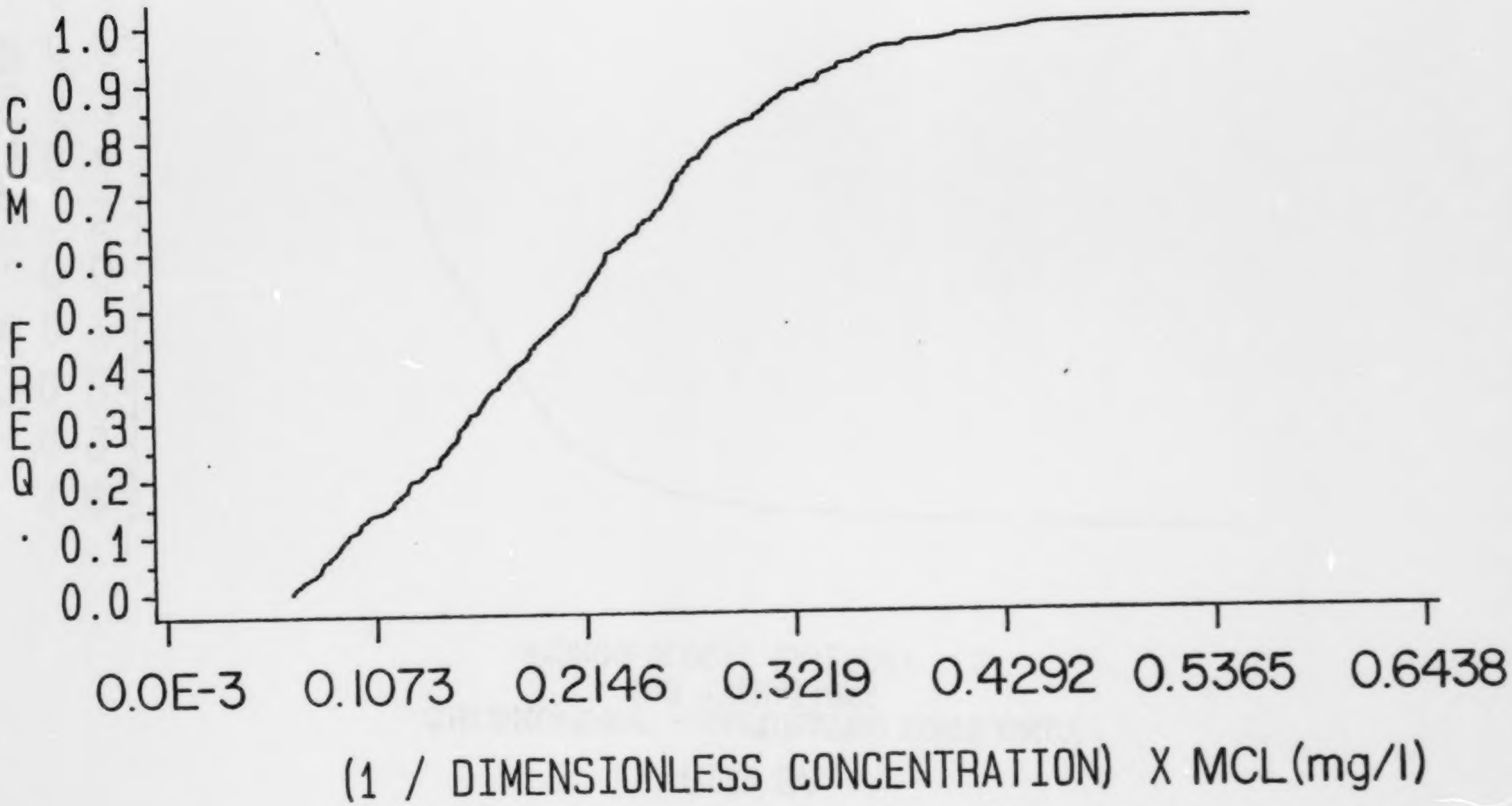
RUN 5

2,4-DINITROTOLUENE – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY - 4



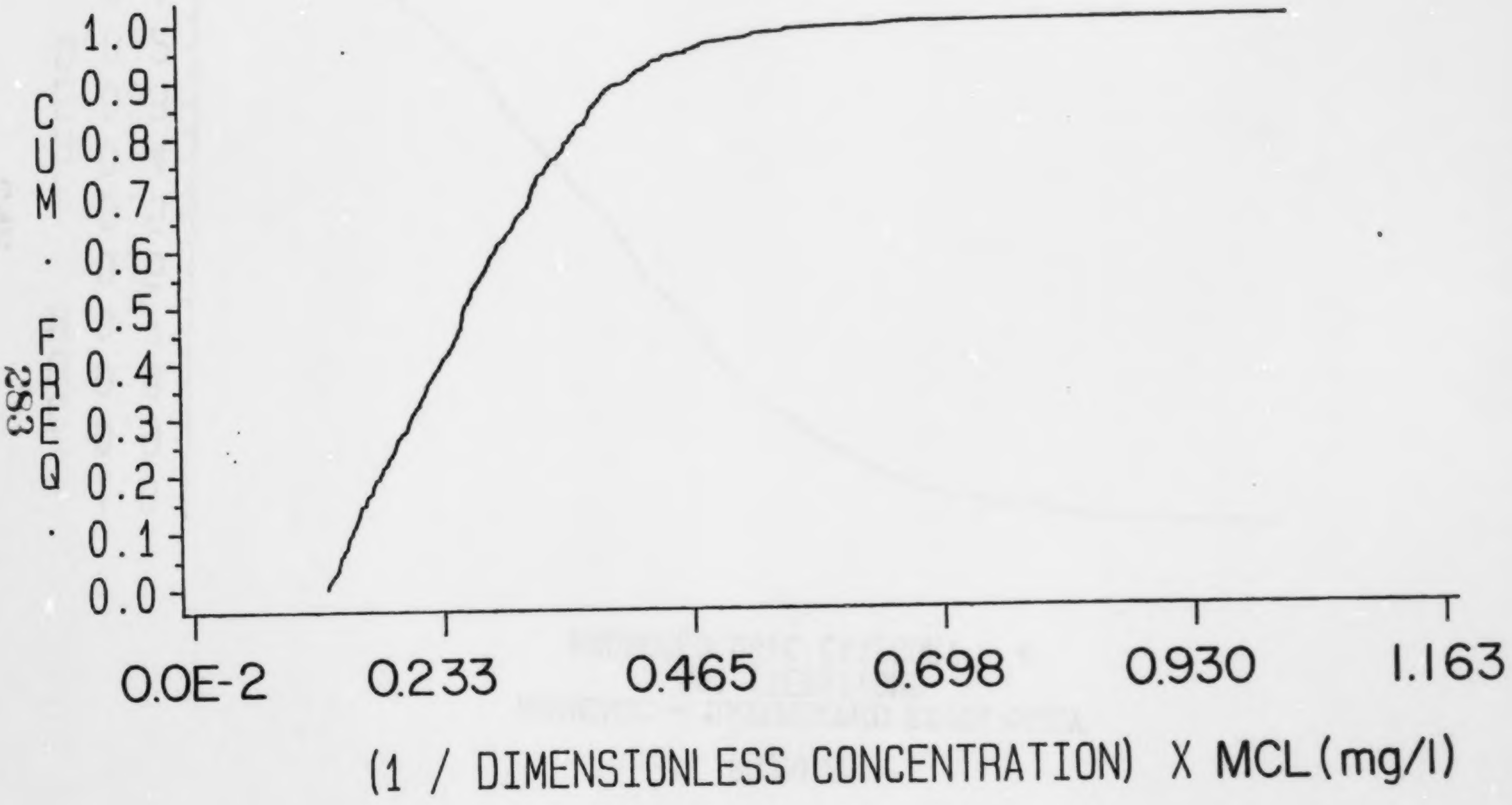
RUN 6

ARSENIC – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY - 4



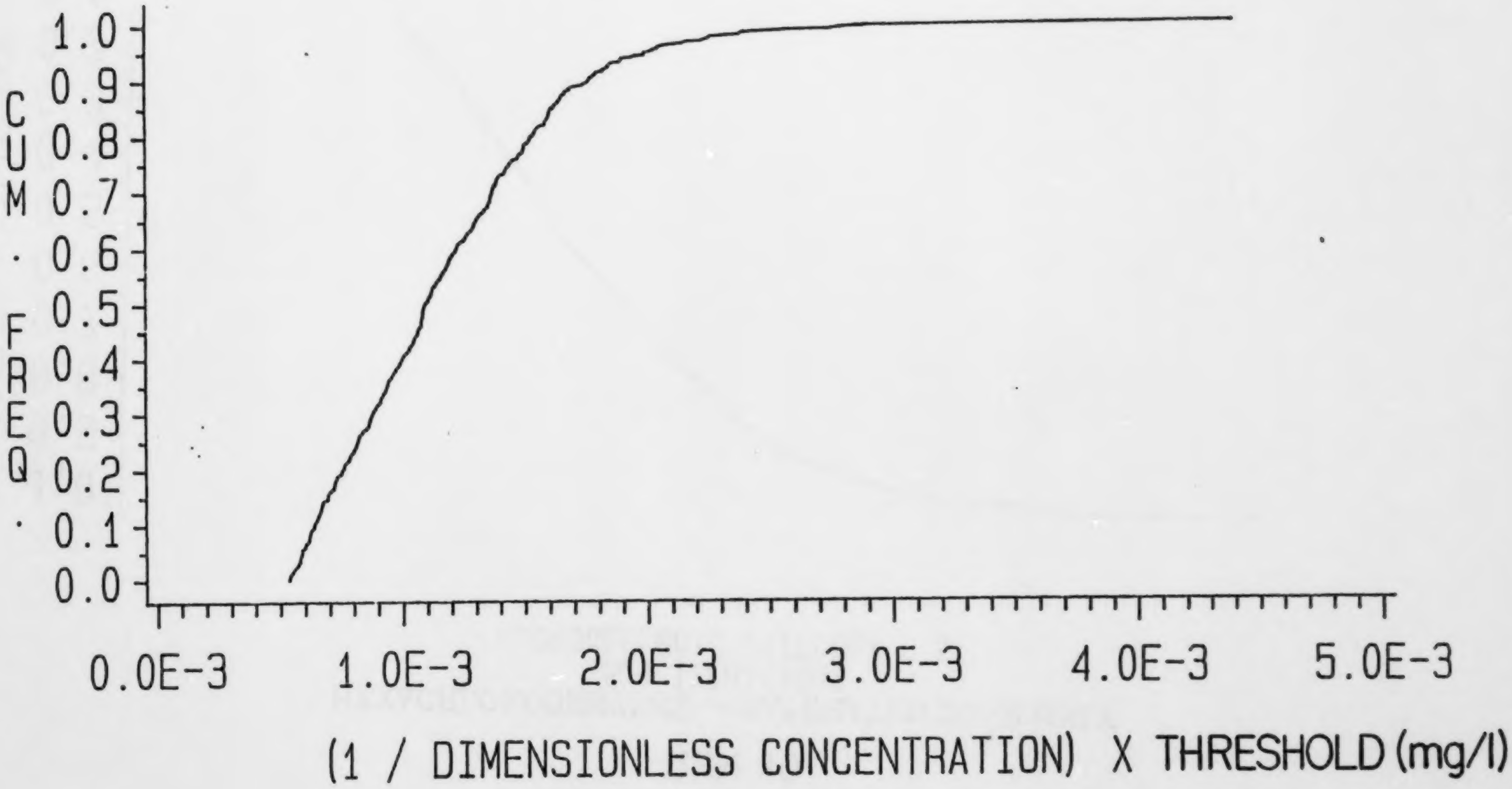
RUN 9A

CHLOROFORM – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY - 5



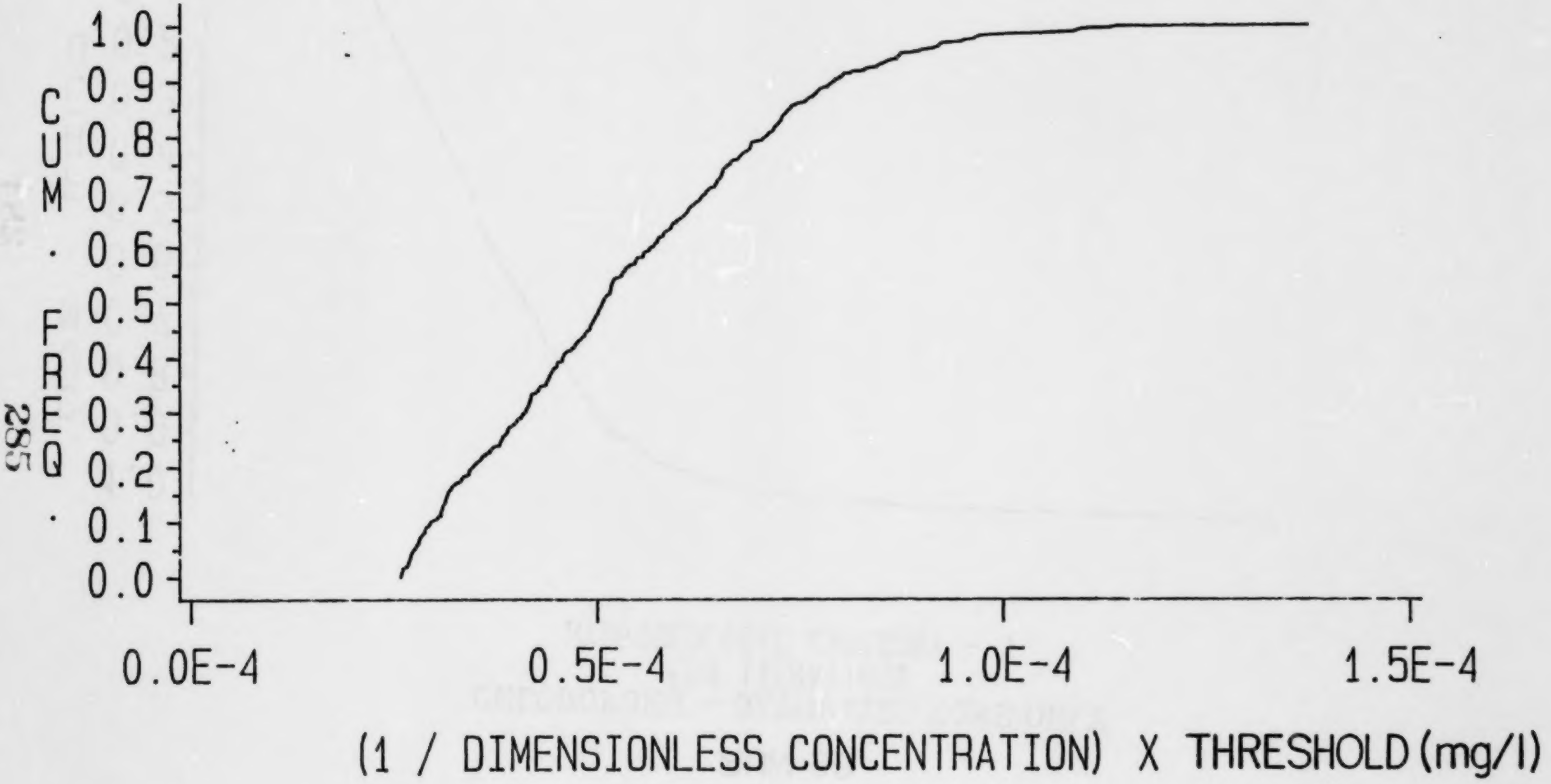
RUN 9B

CHLOROFORM – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY - 5



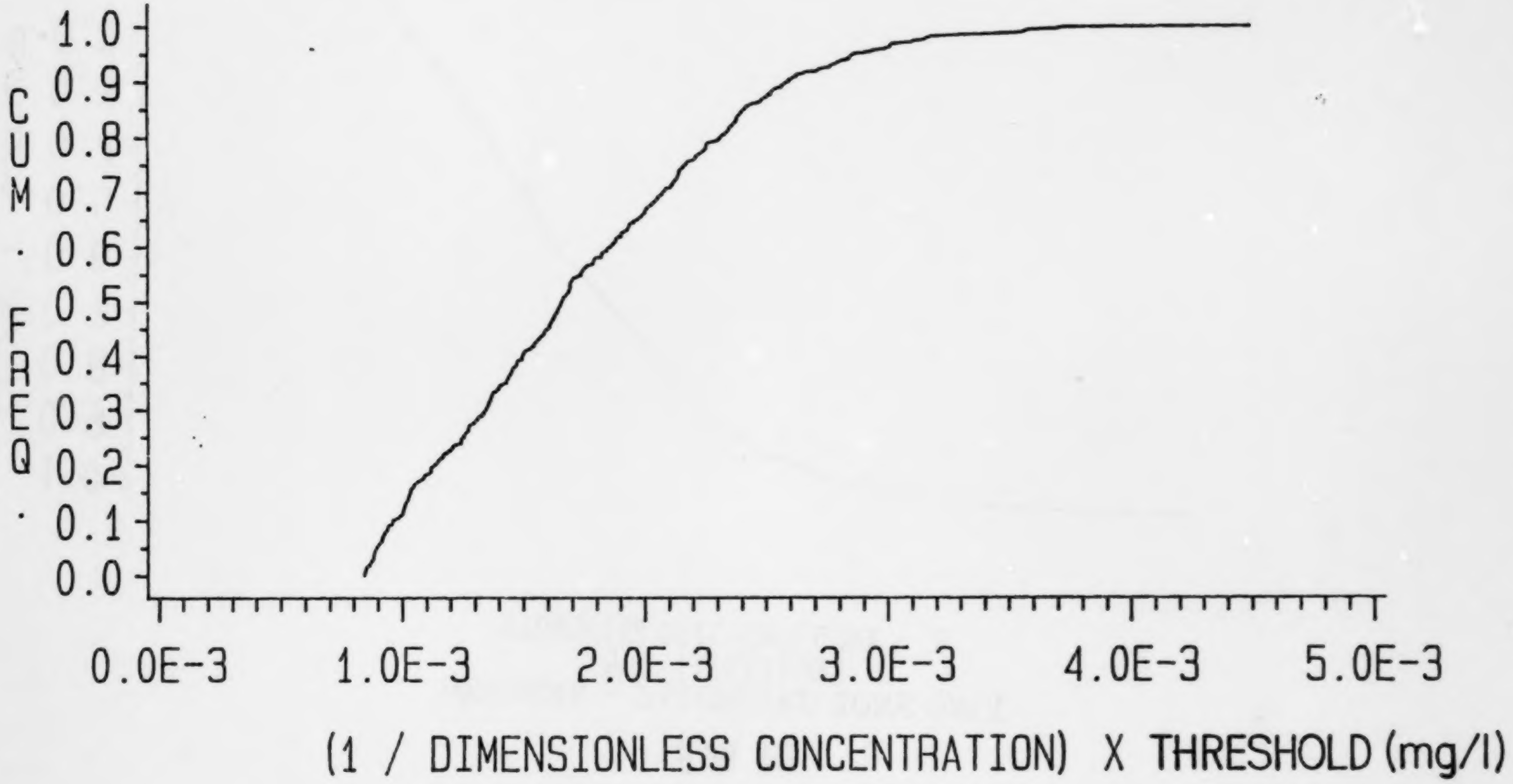
RUN 10

HEXACHLOROBENZENE – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY – 5



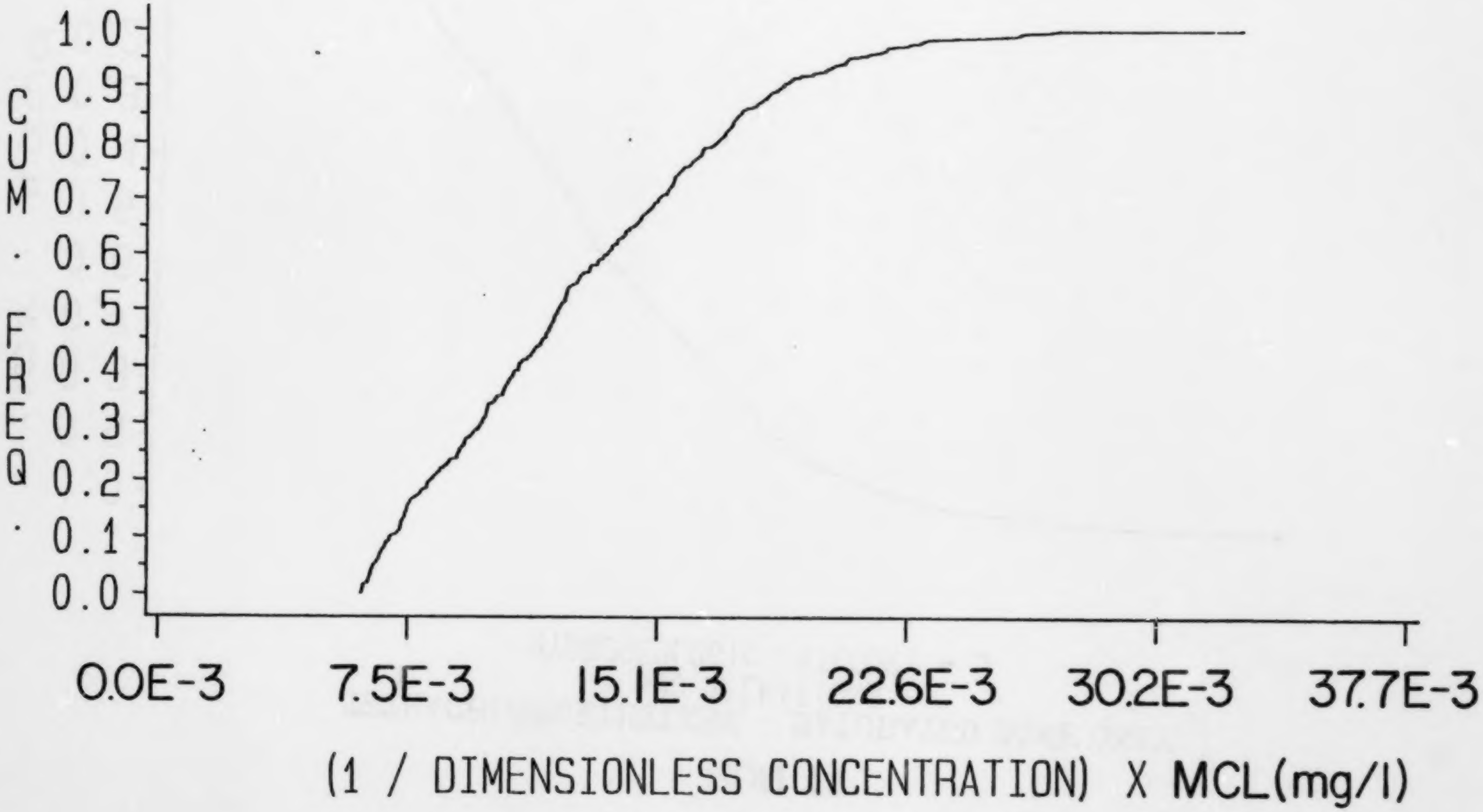
RUN 11

TETRACHLOROETHYLENE – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY - 5



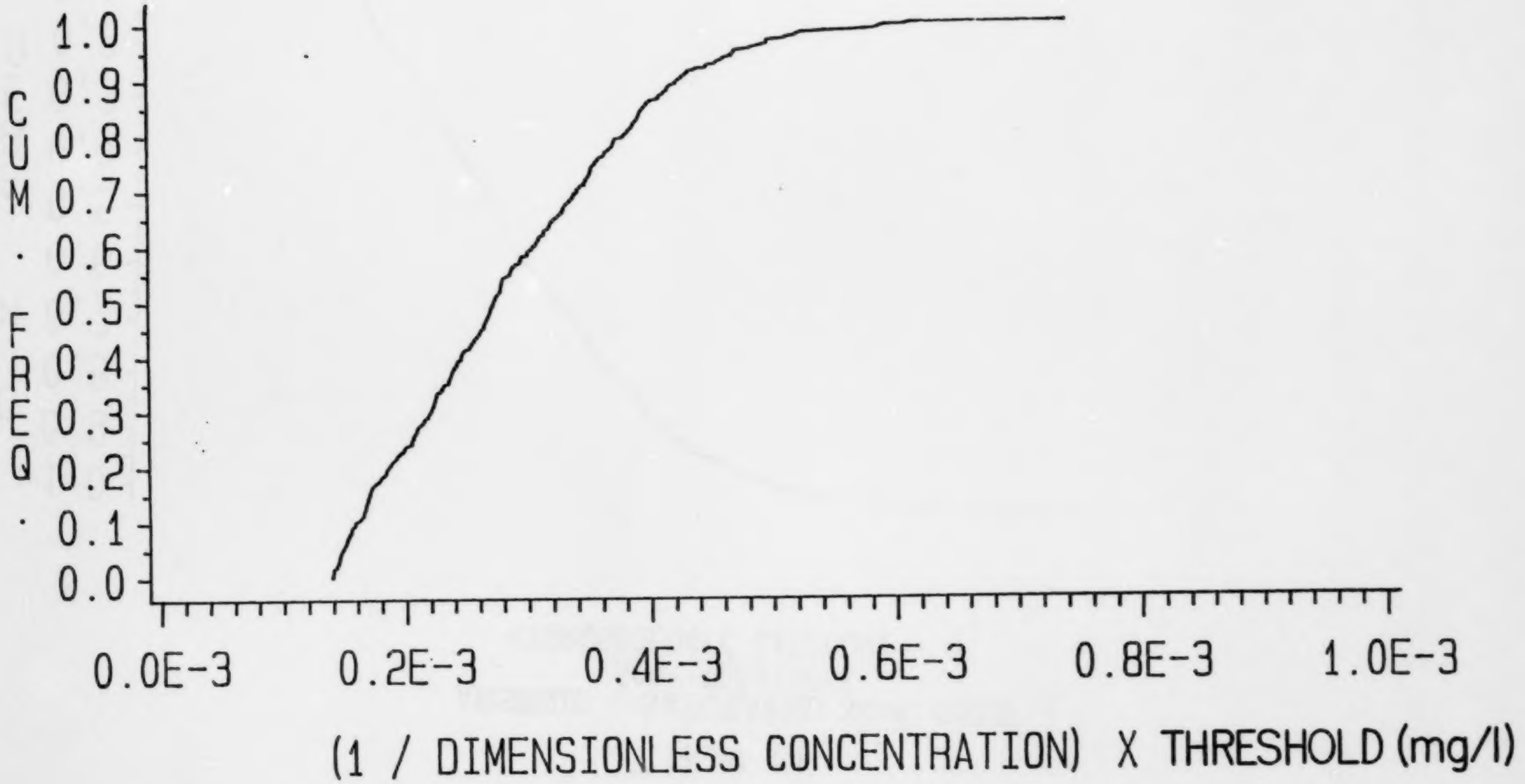
RUN 12

BENZENE – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY - 5



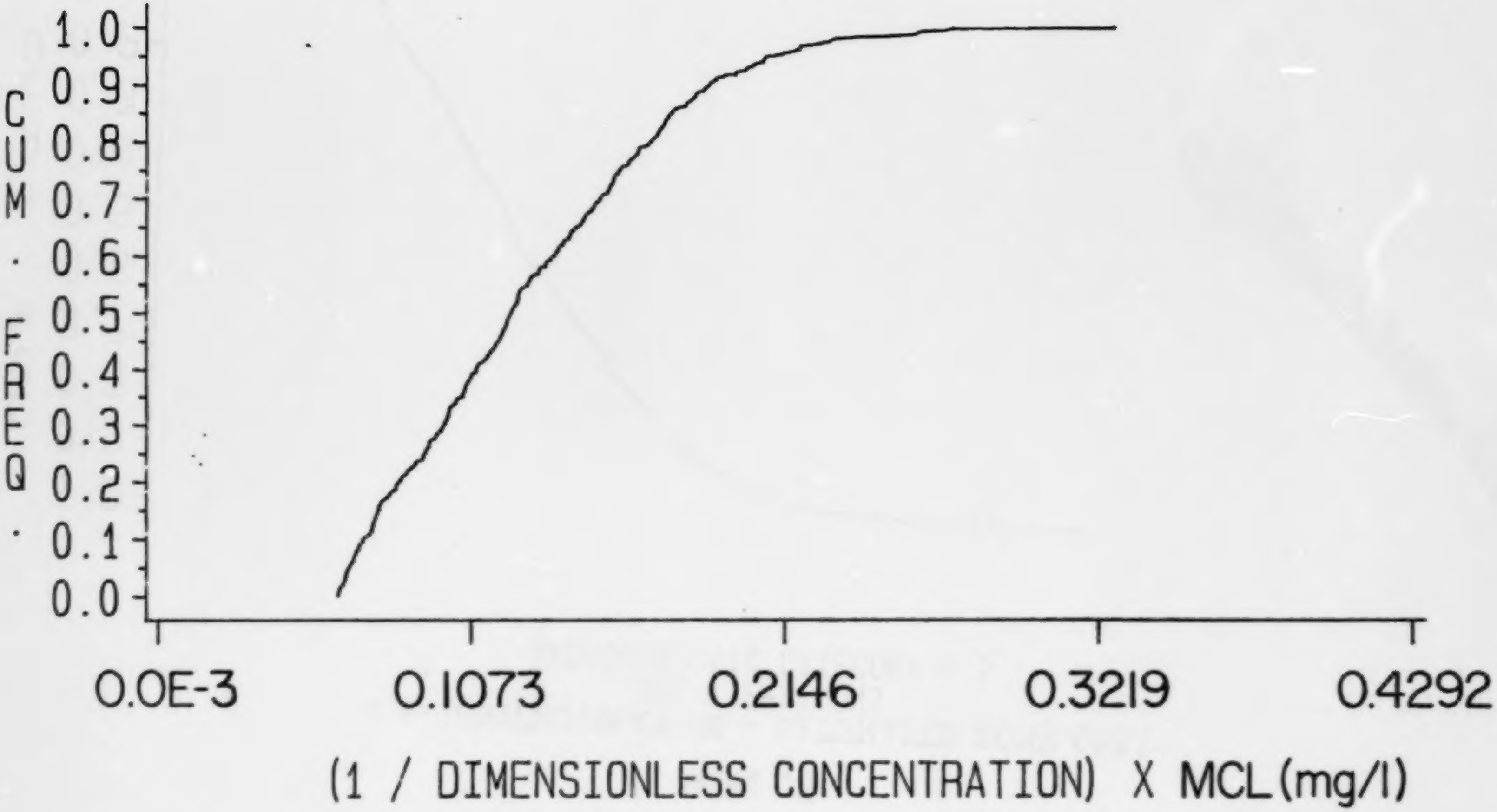
RUN 13

2,4–DINITROTOLUENE – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY – 5



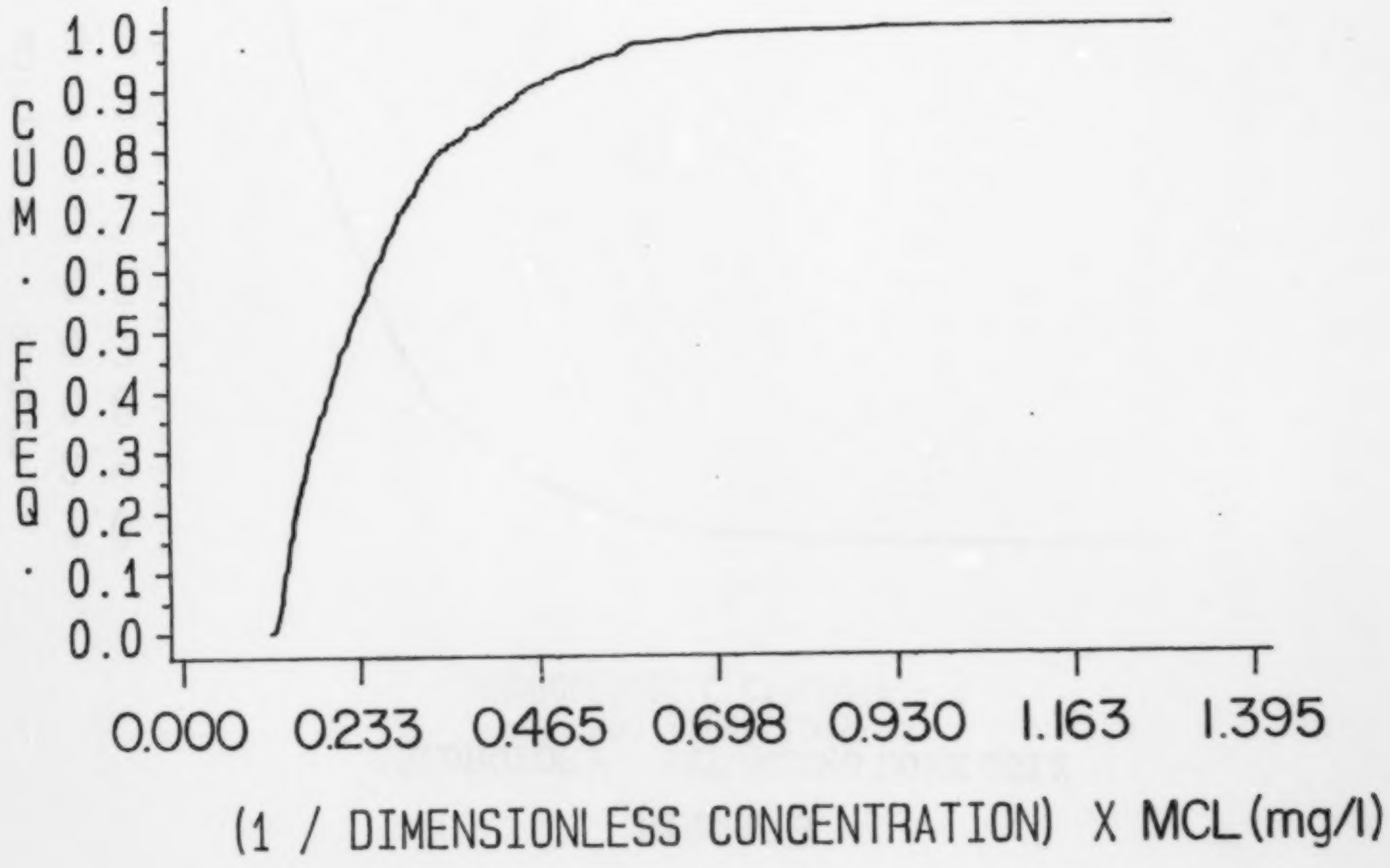
RUN 14

ARSENIC – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY – 5



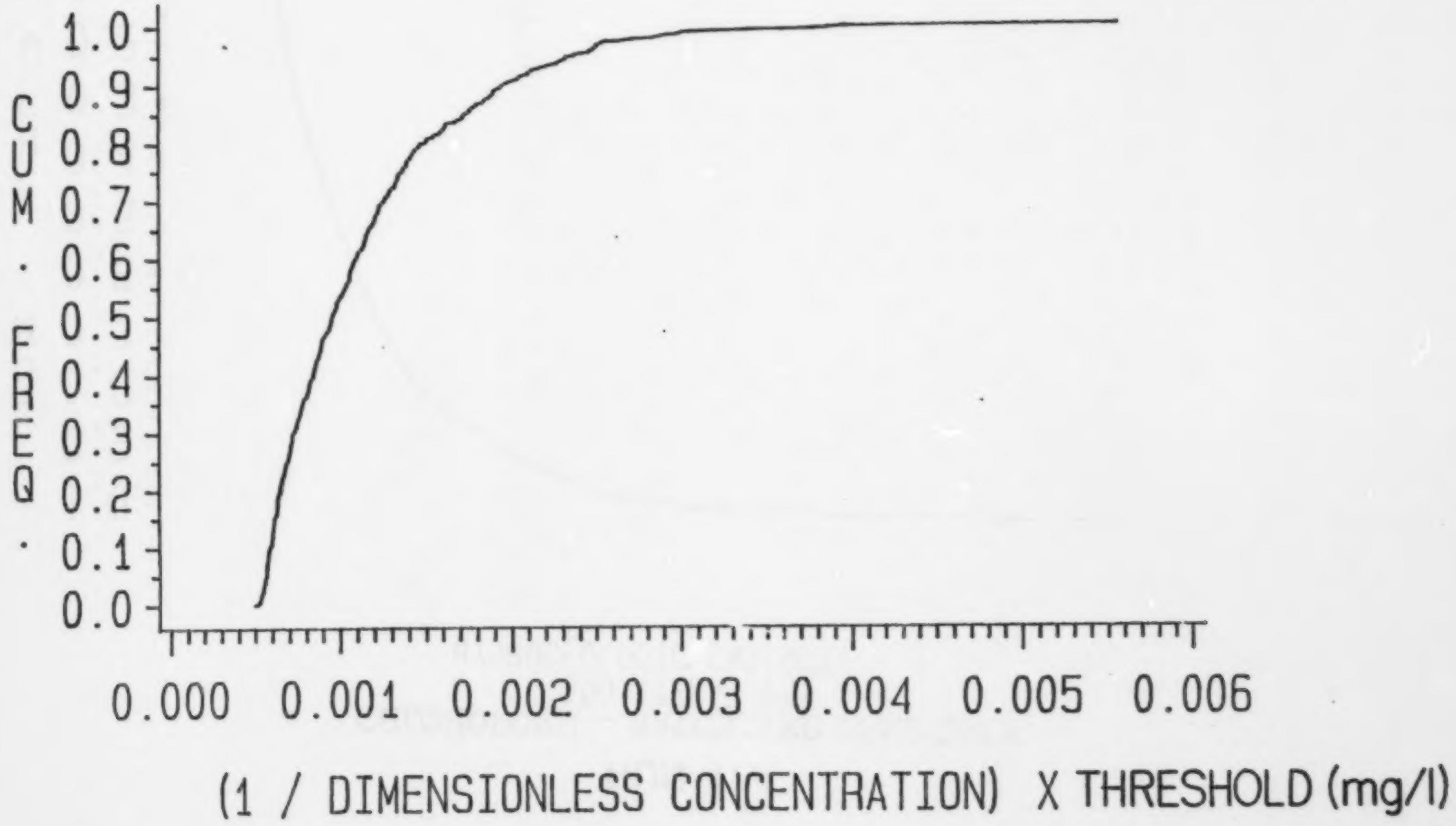
RUN 17A

CHLOROFORM – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY – 1



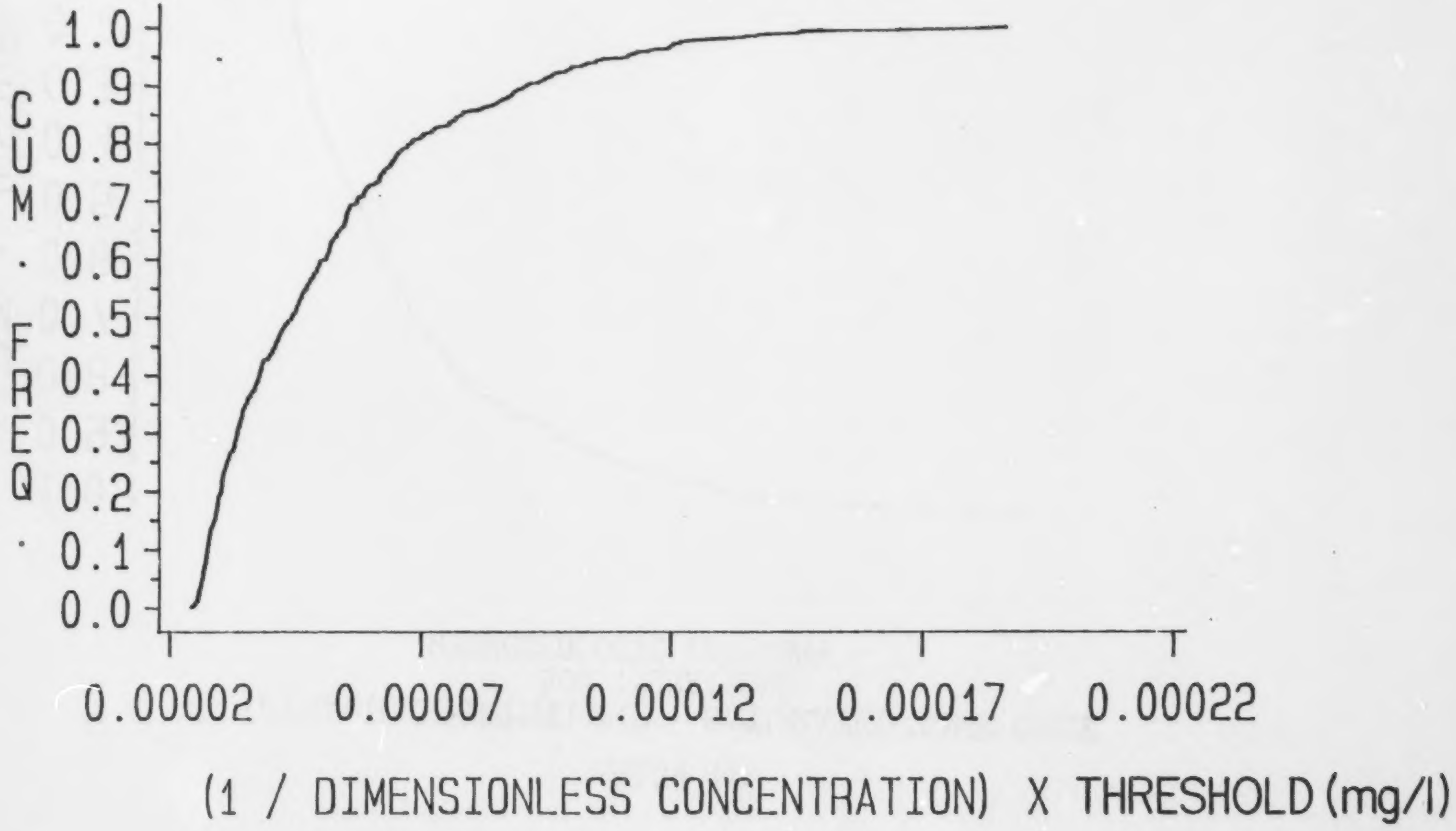
RUN 17B

CHLOROFORM – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY - 1



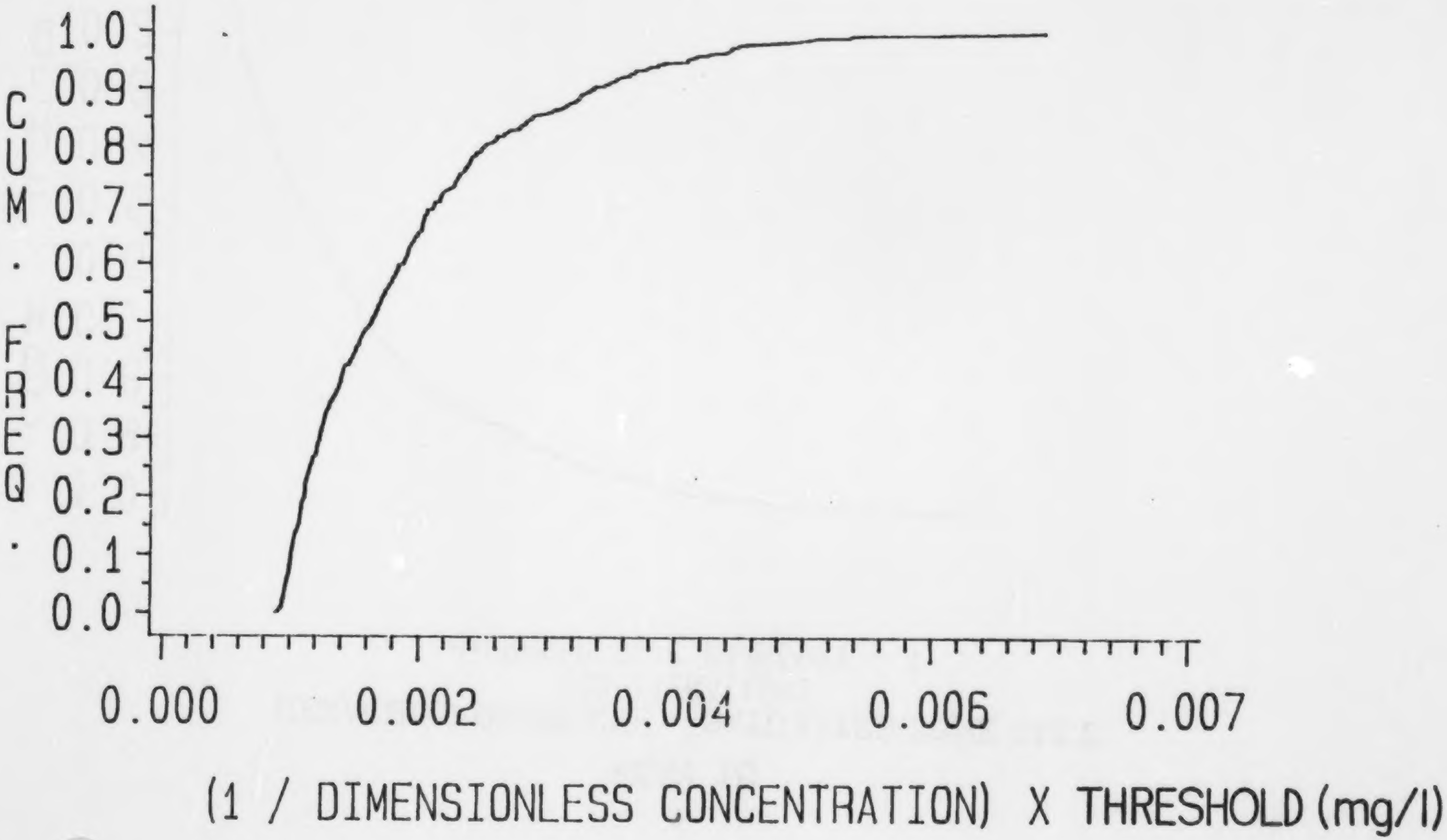
RUN 18

HEXACHLOROBENZENE – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY - 1



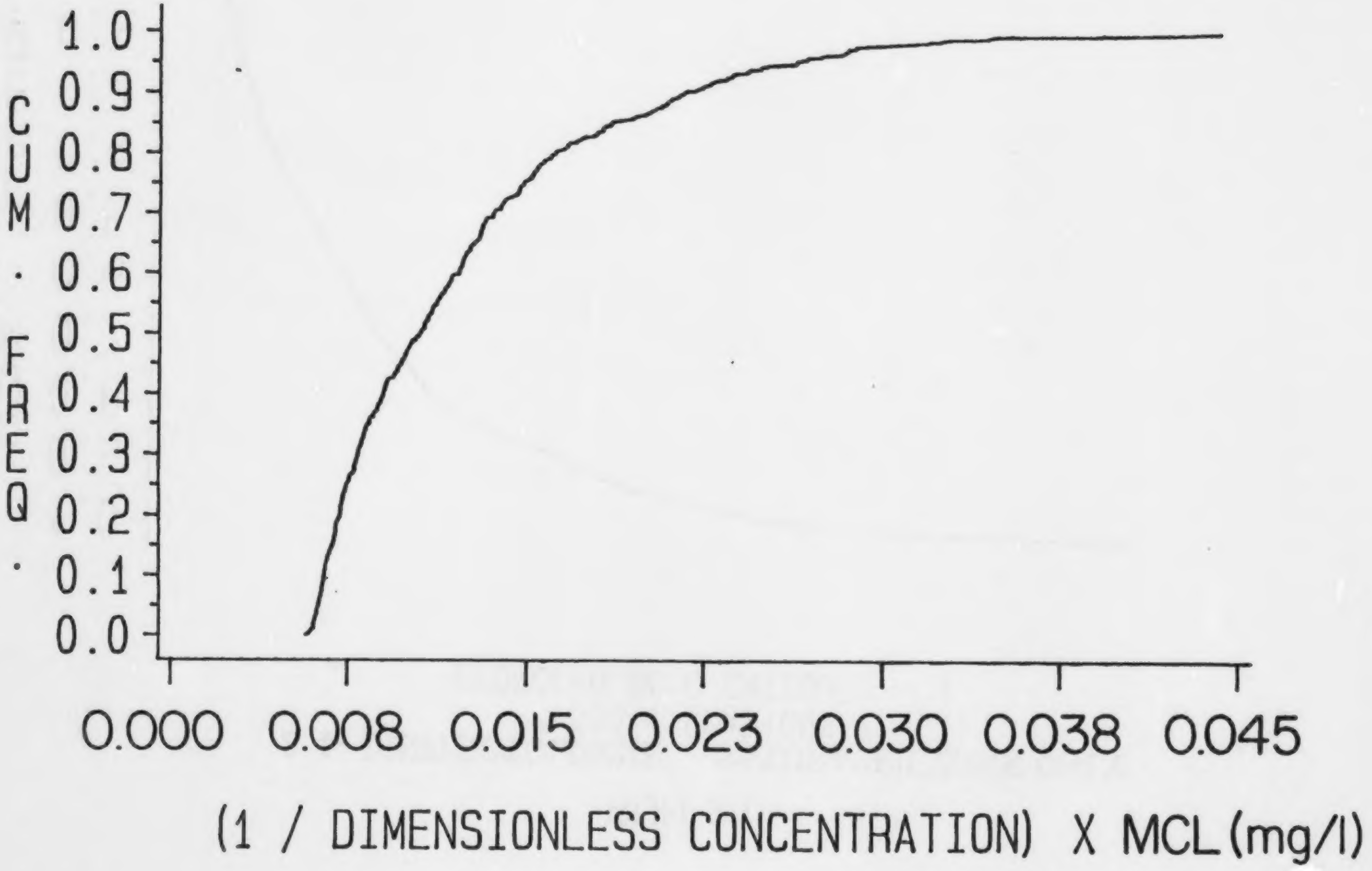
RUN 19

TETRACHLOROETHYLENE – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY – 1



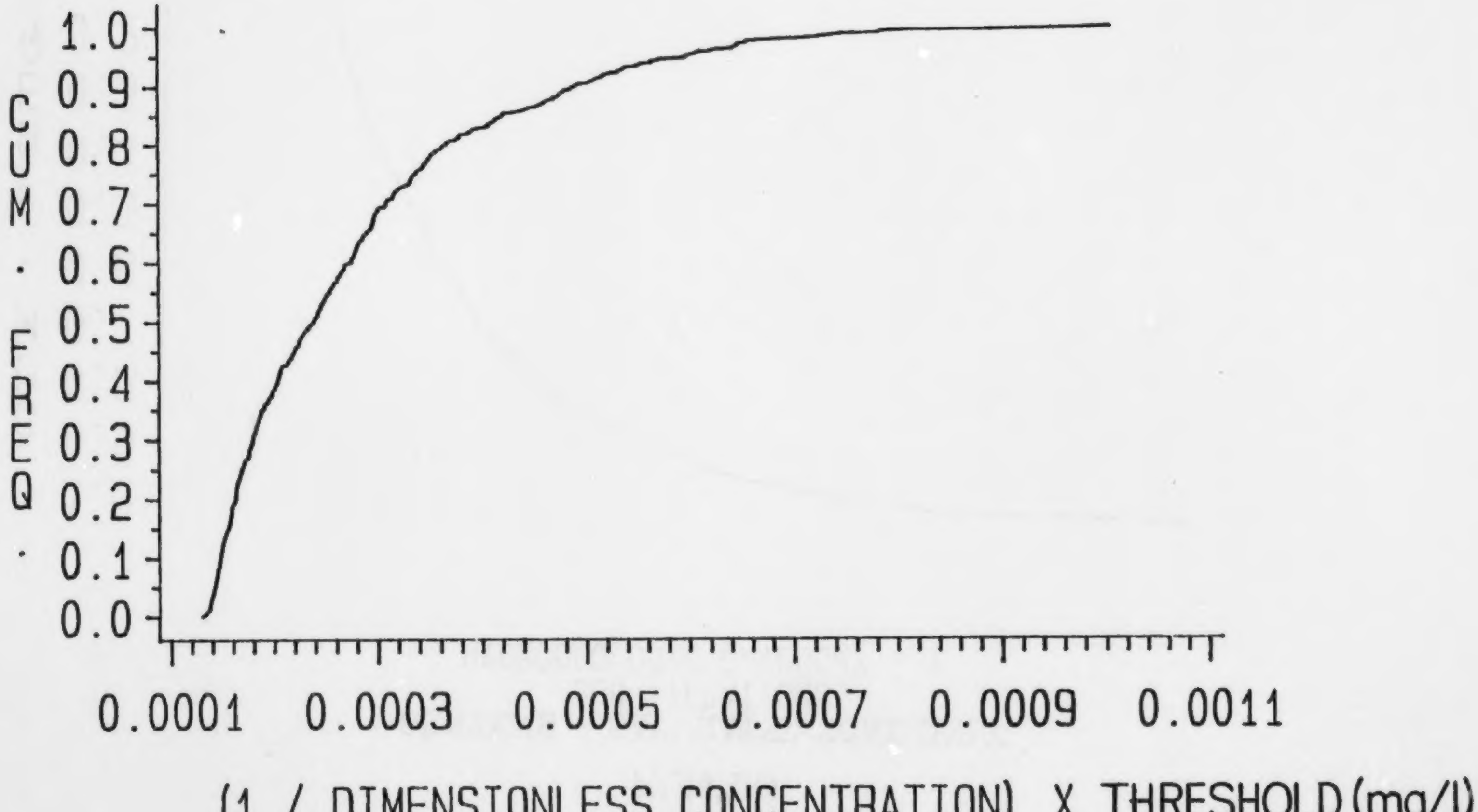
RUN 20

BENZENE – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY - 1



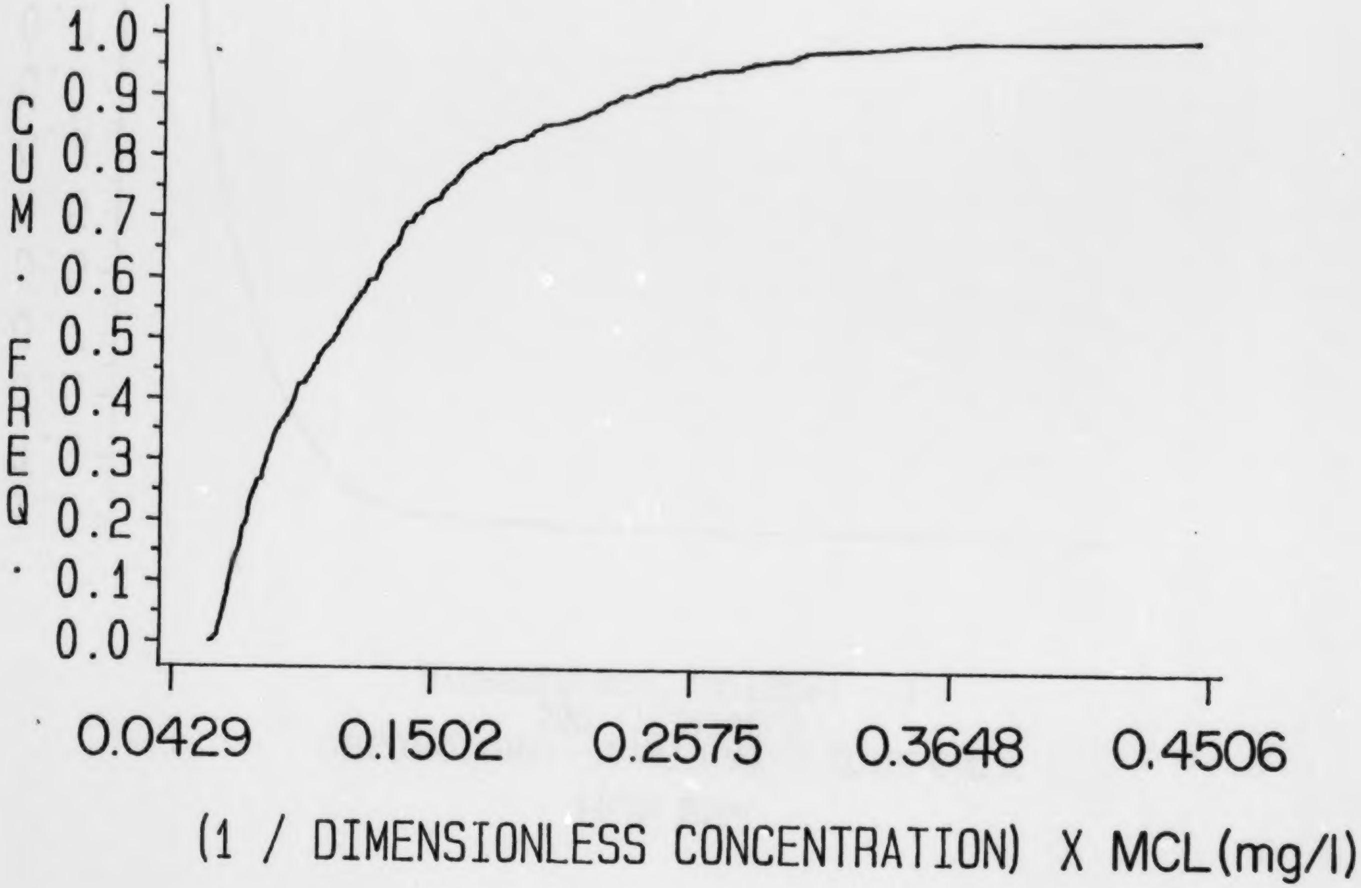
RUN 21

2,4-DINITROTOLUENE – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY - 1



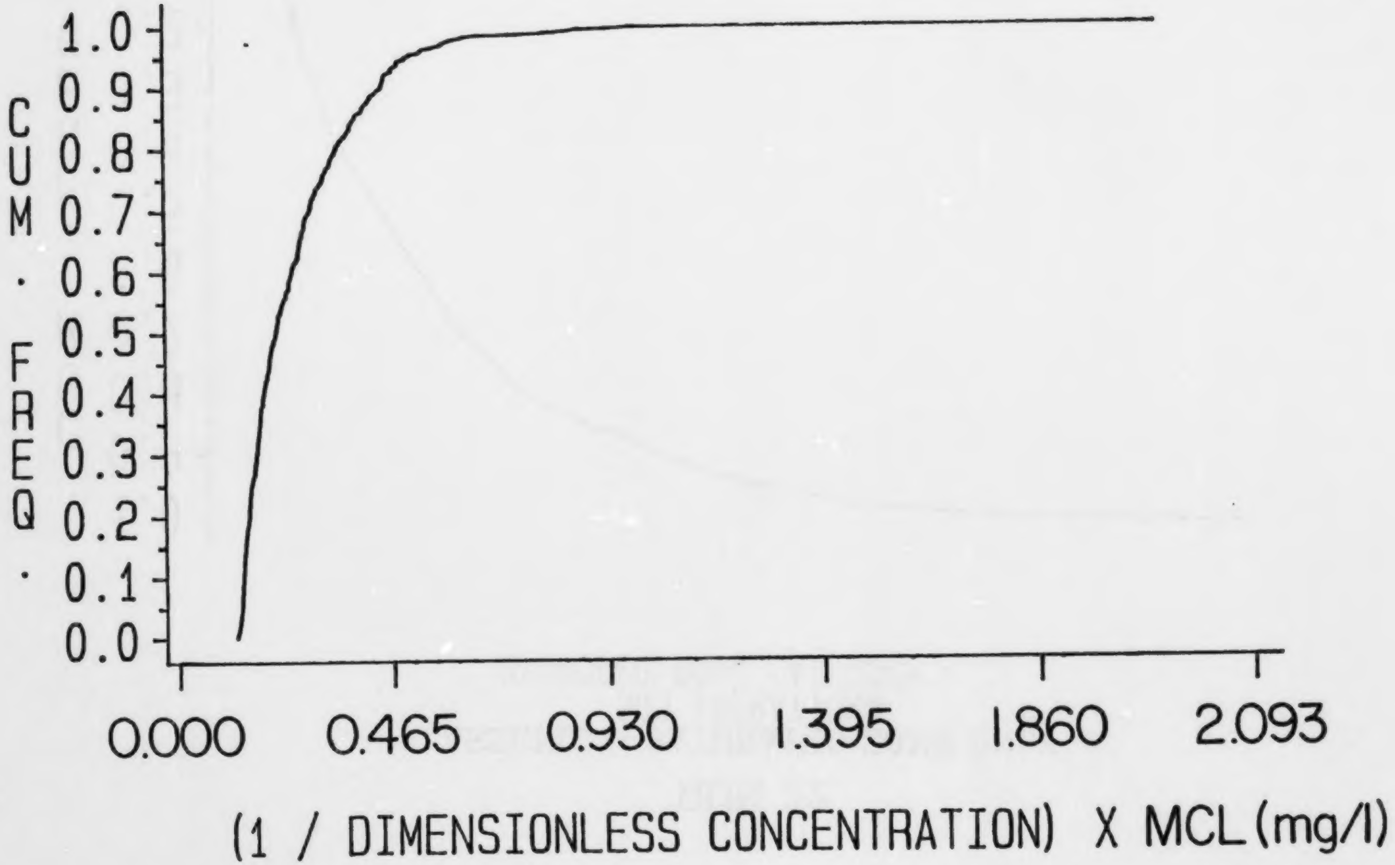
RUN 22

ARSENIC – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY – 1



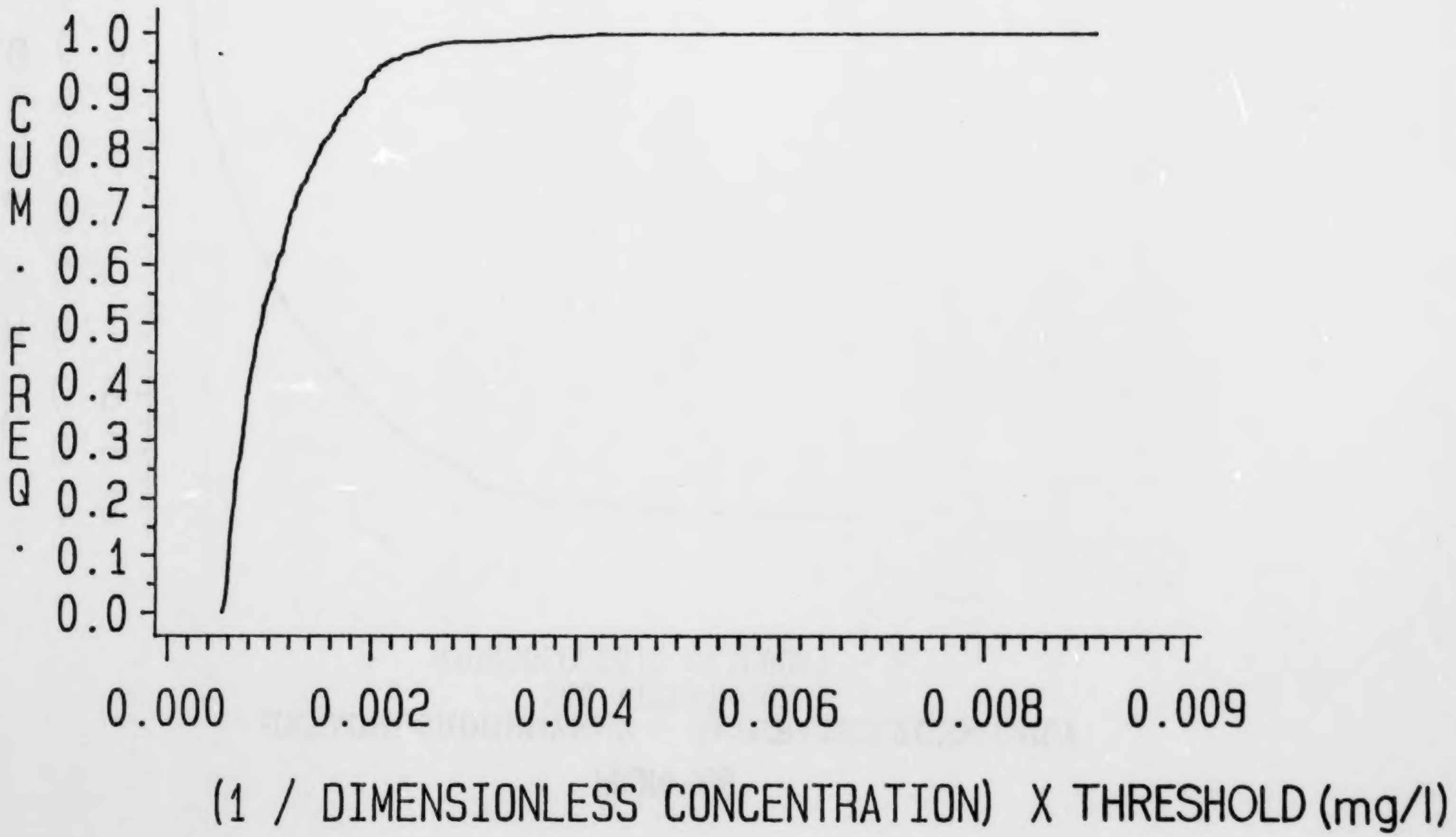
RUN 25A

CHLOROFORM – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY – 2



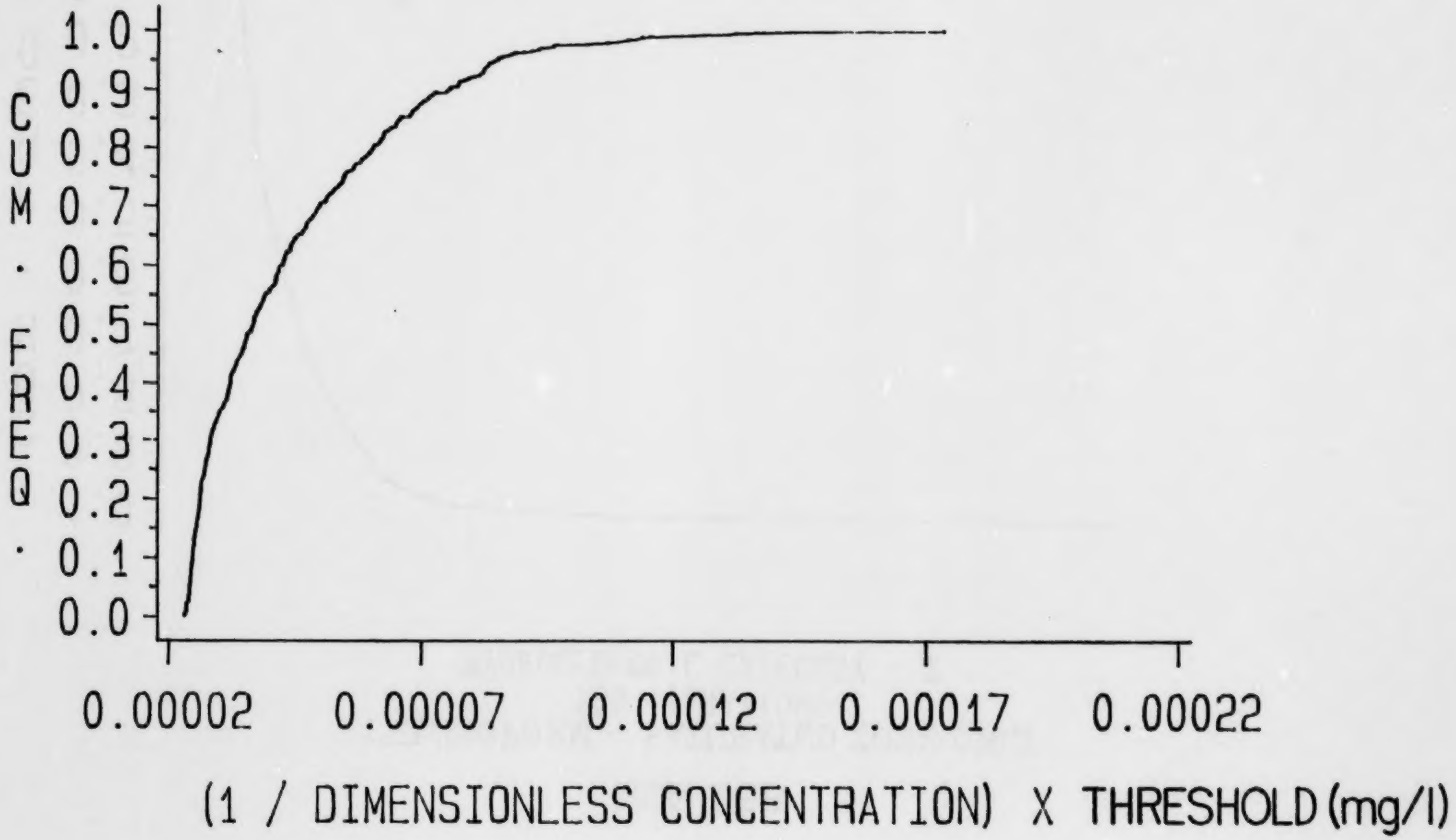
RUN 25B

CHLOROFORM – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY – 2



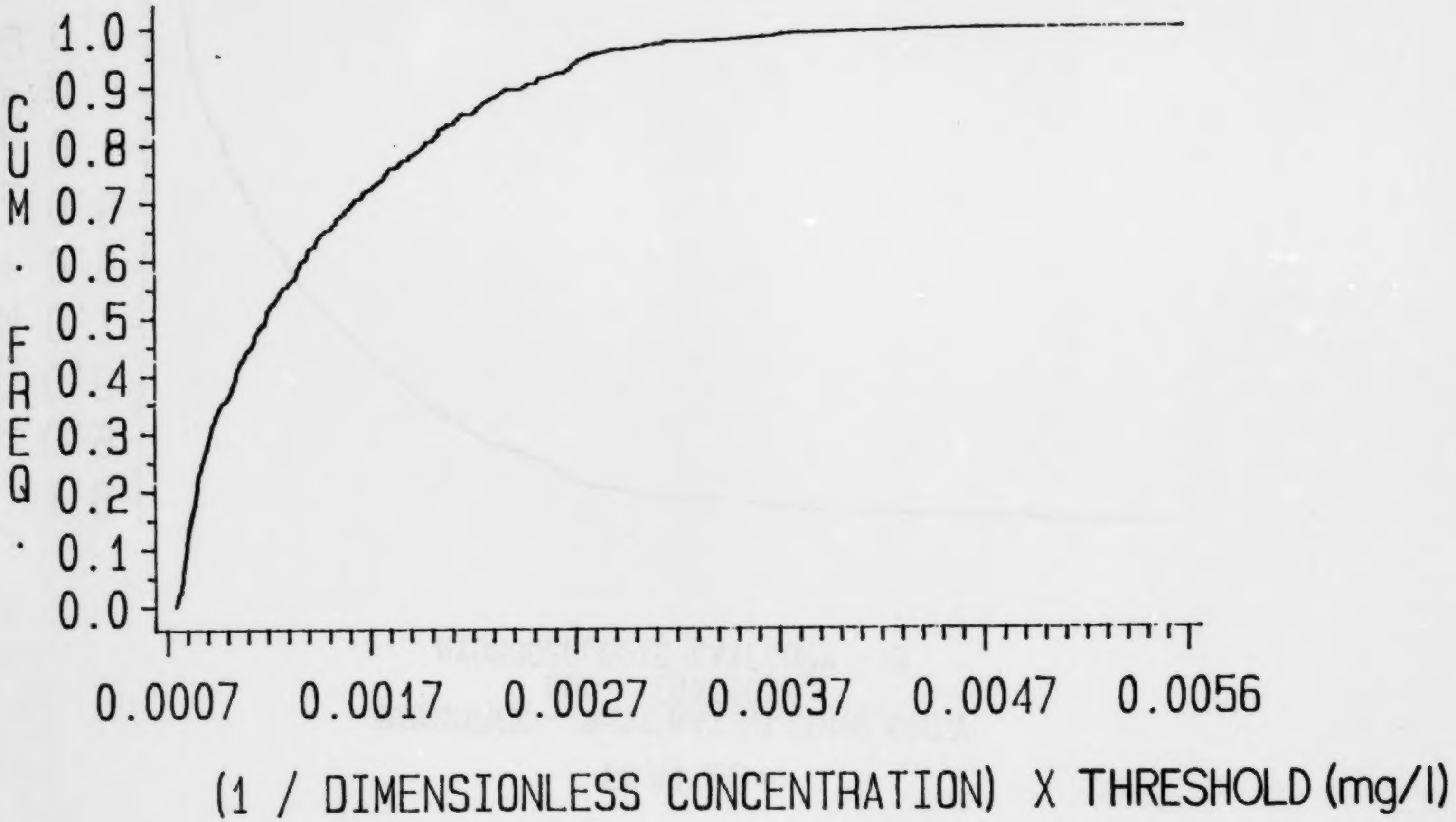
RUN 26

HEXACHLOROBENZENE – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY - 2



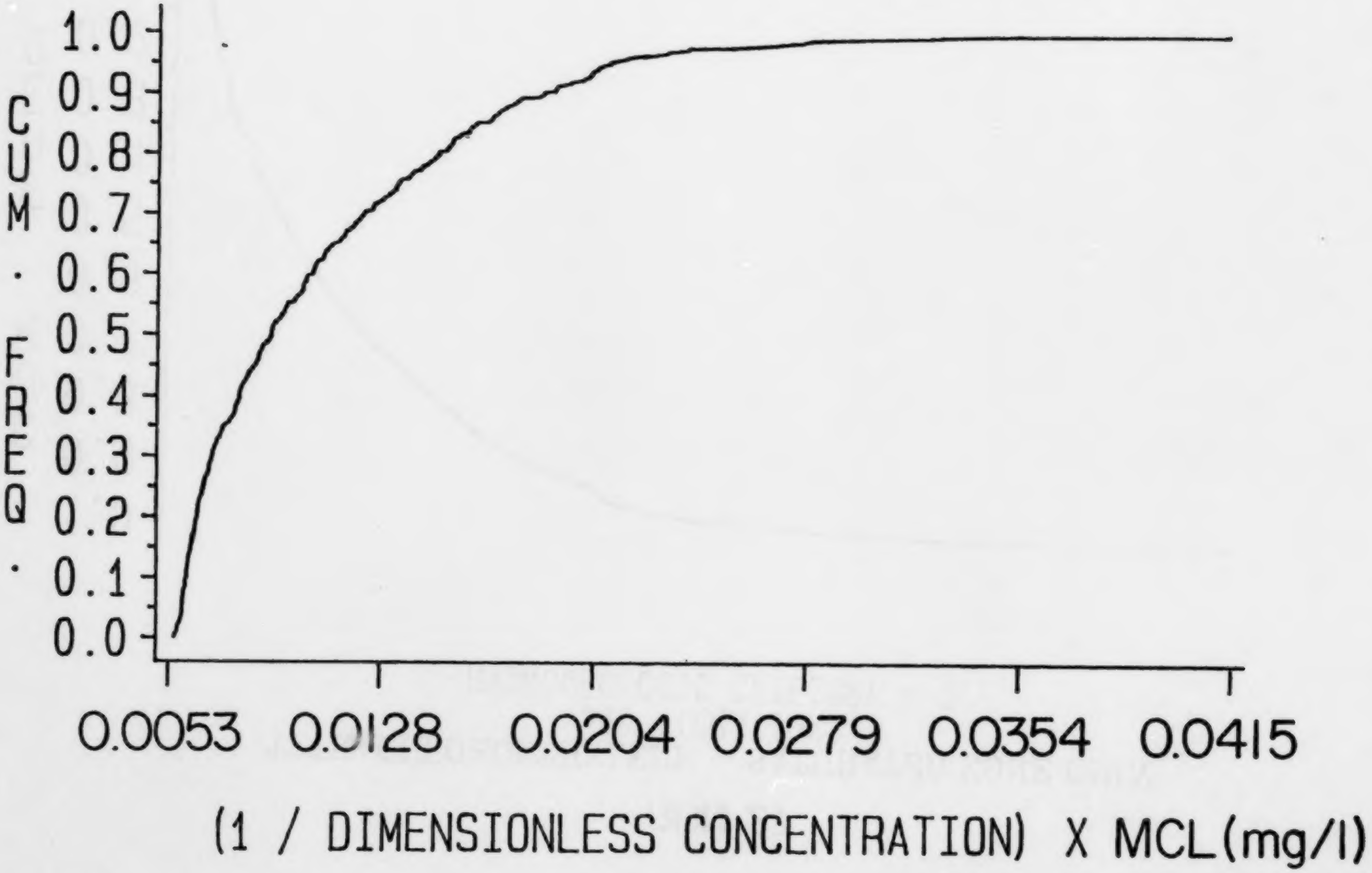
RUN 27

TETRACHLOROETHYLENE – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY – 2



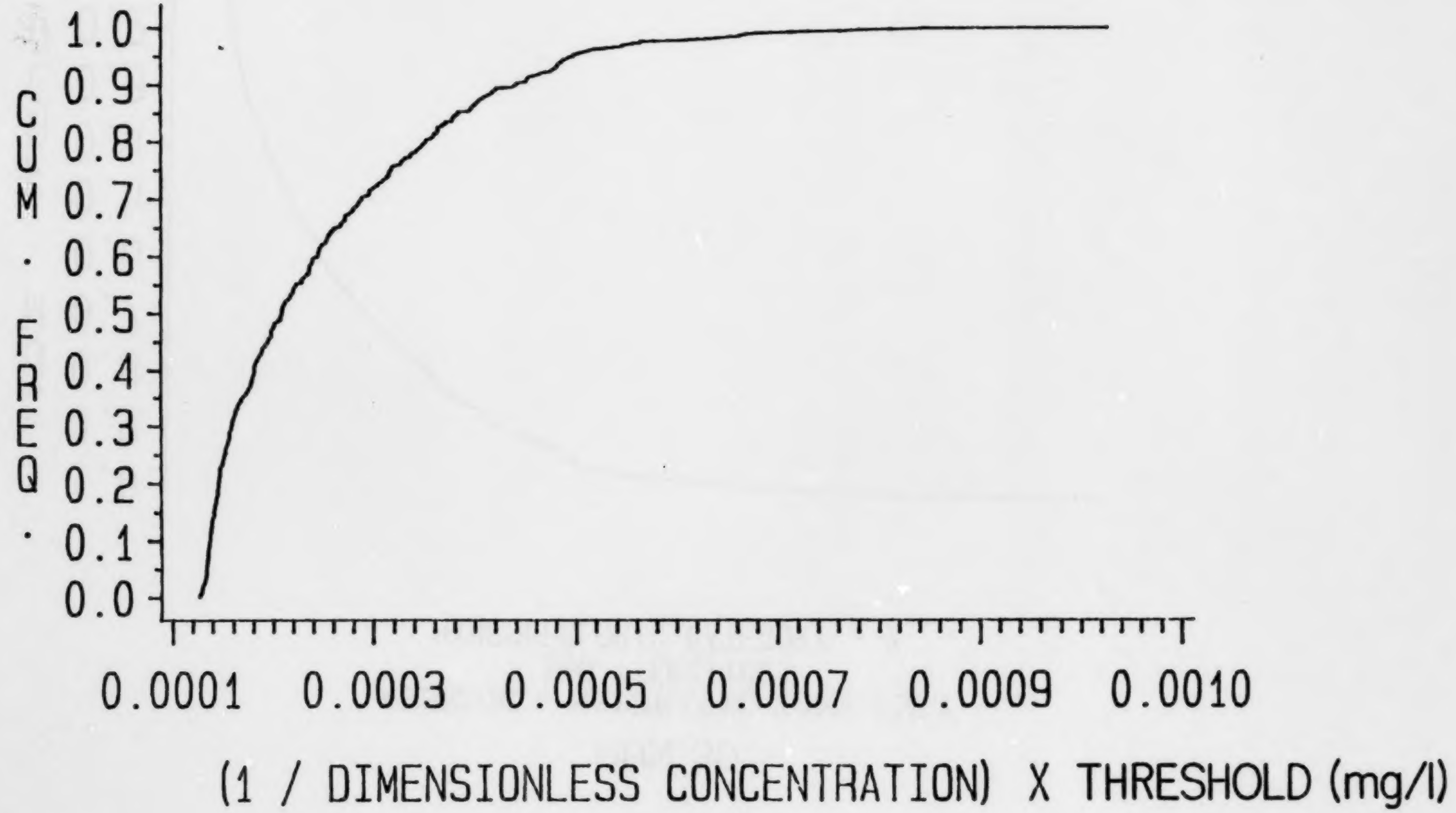
RUN 28

BENZENE – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY - 2



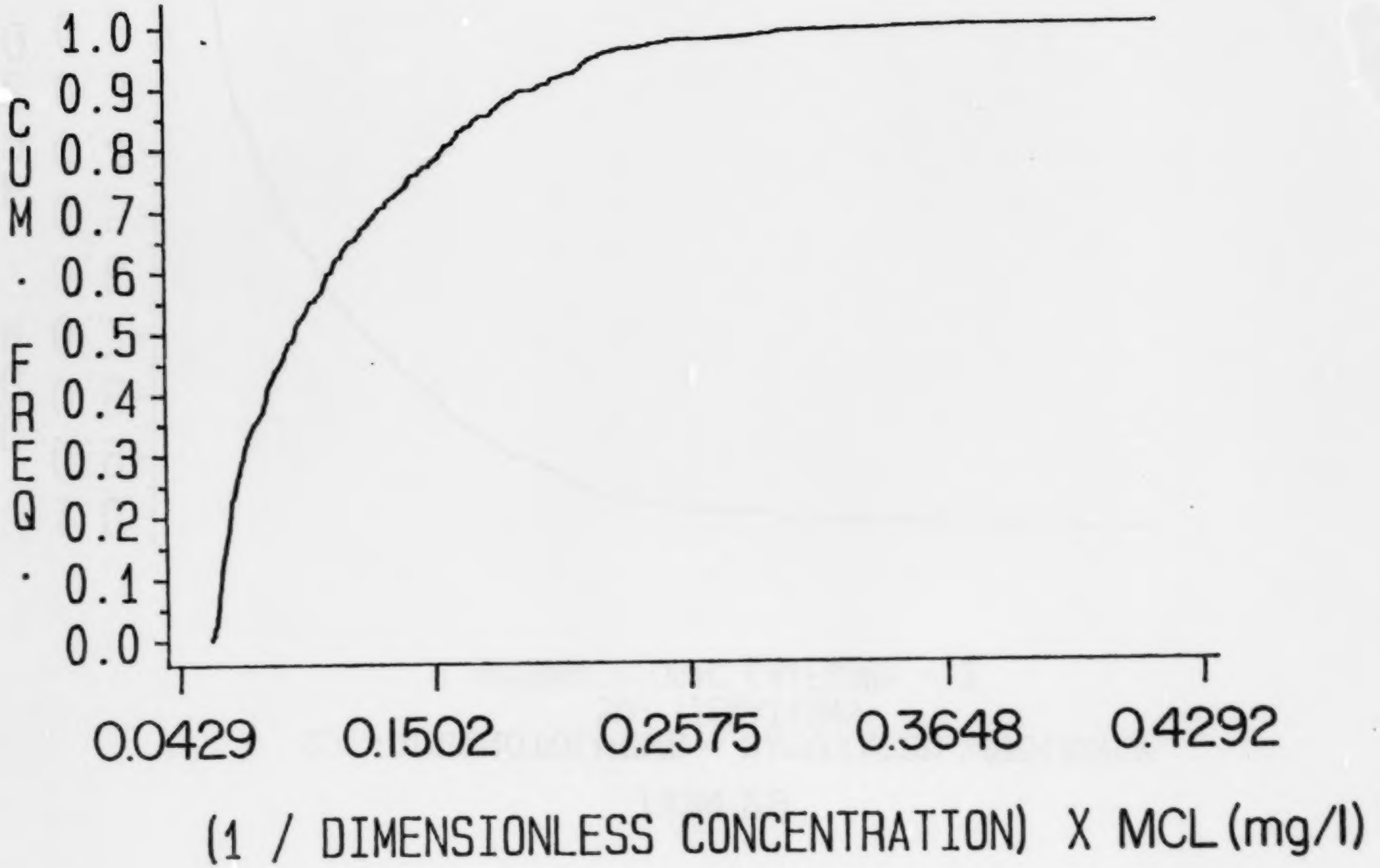
RUN 29

2,4-DINITROTOLUENE – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY - 2



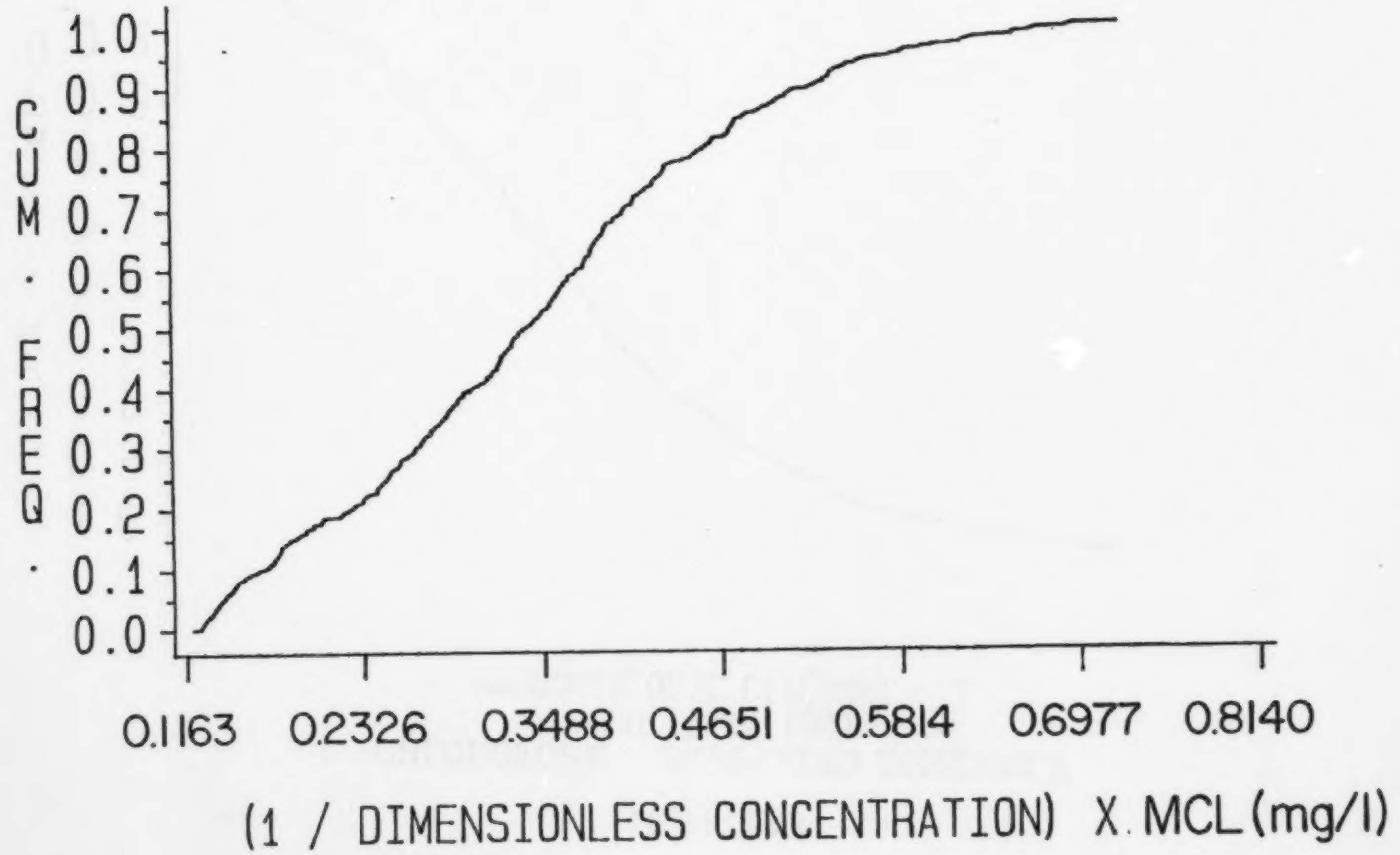
RUN 30

ARSENIC – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY – 2



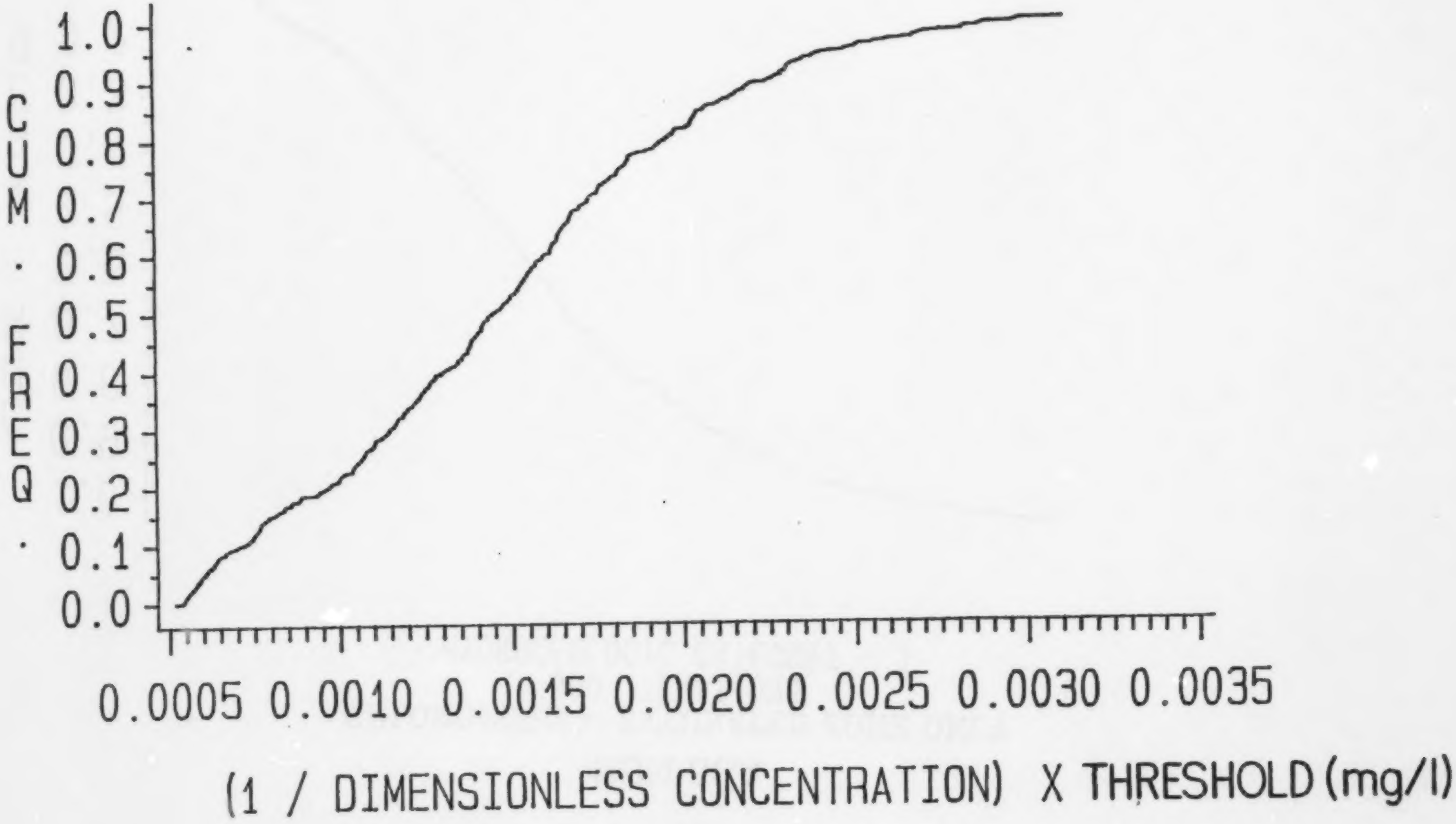
RUN 33A

CHLOROFORM – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY – 3



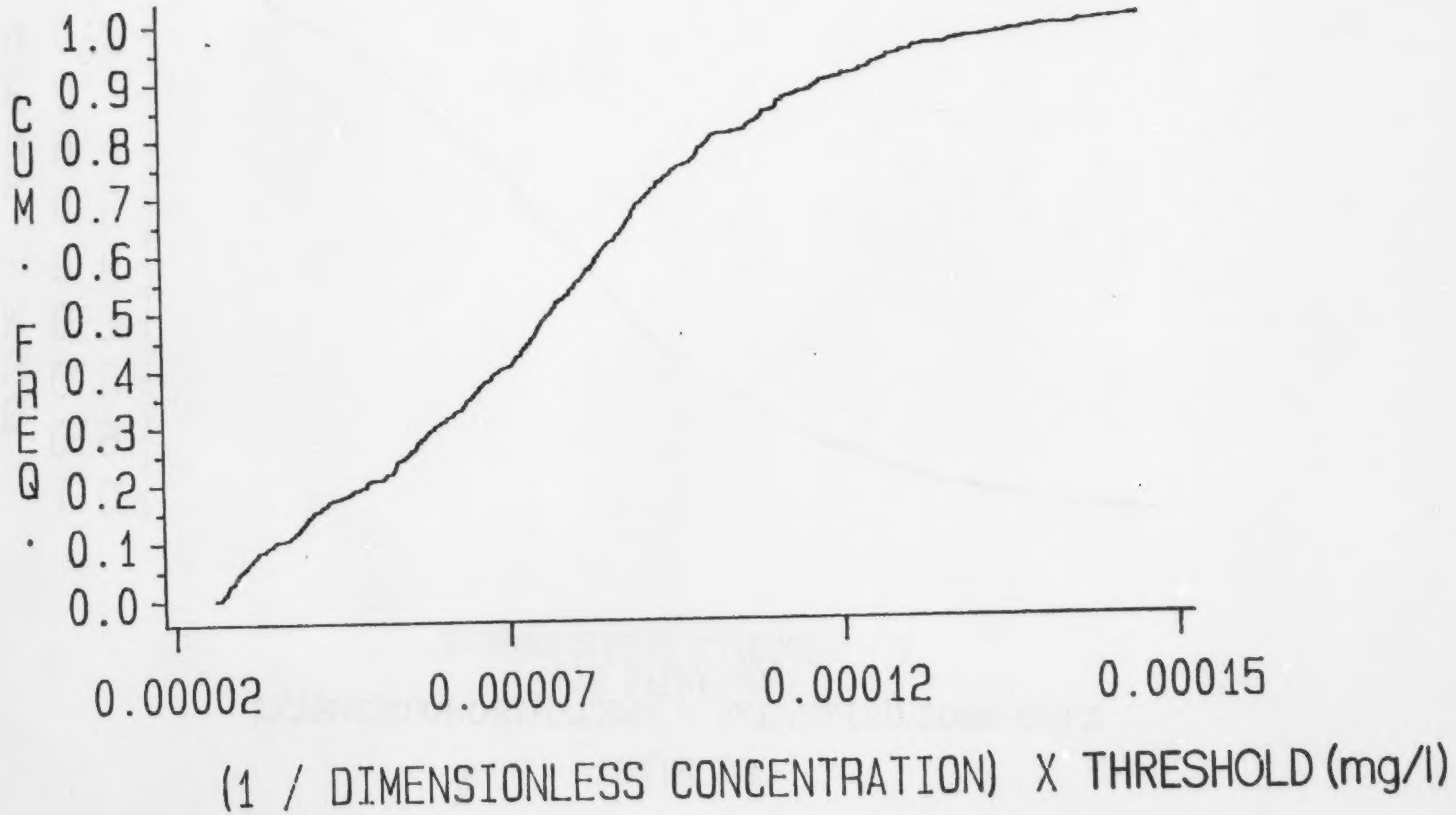
RUN 33B

CHLOROFORM – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY – 3



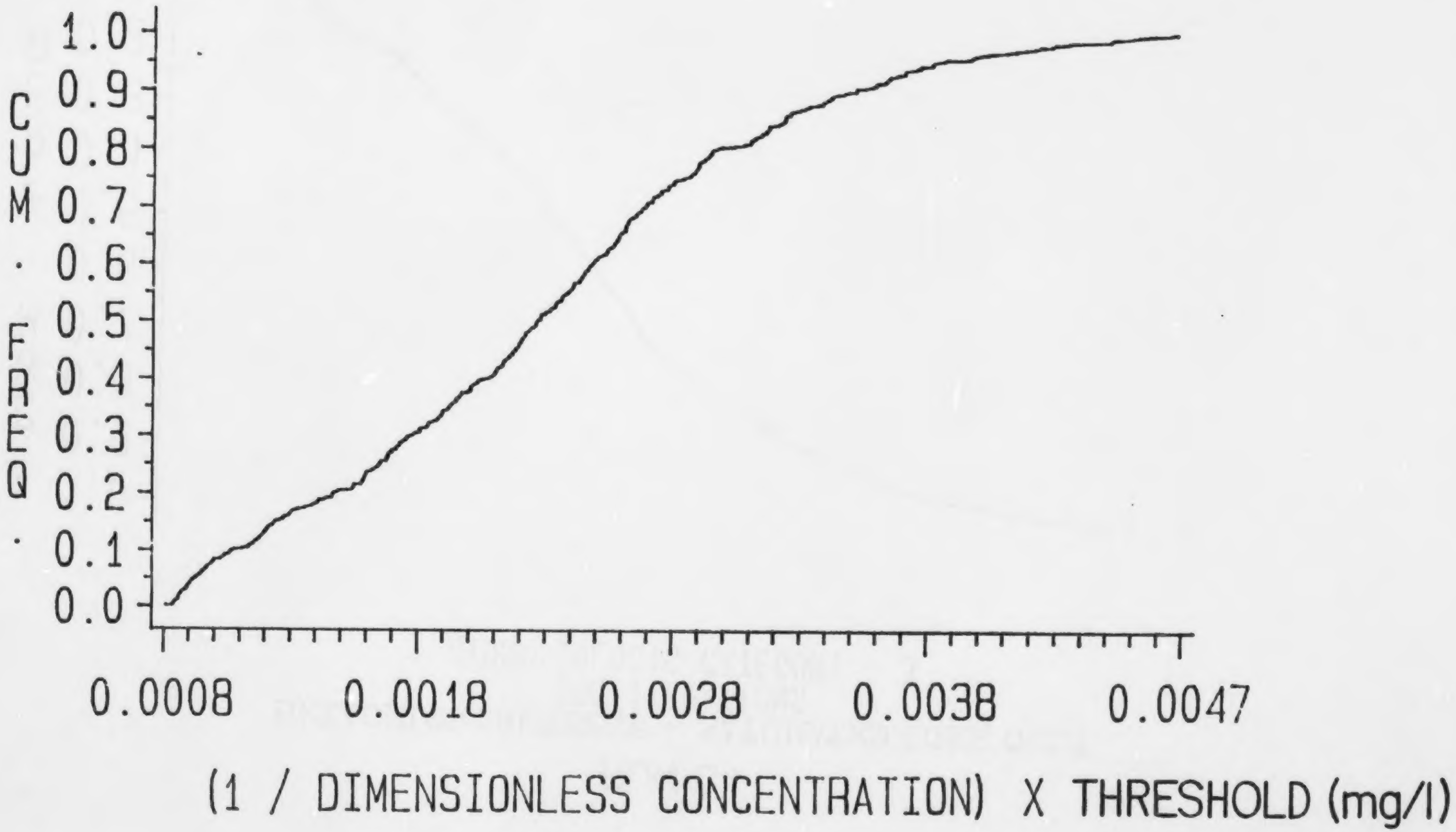
RUN 34

HEXACHLOROBENZENE – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY - 3



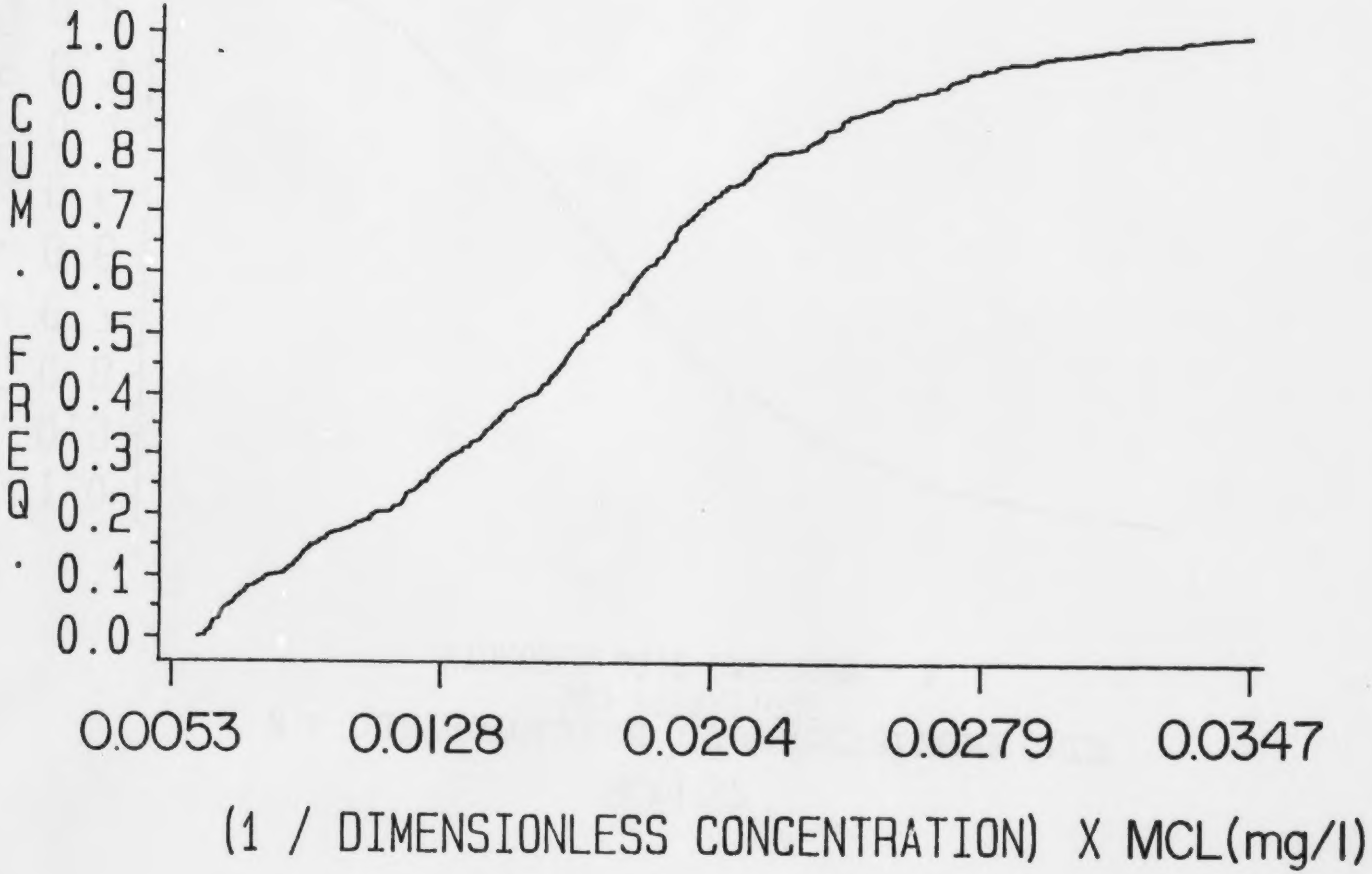
RUN 35

TETRACHLOROETHYLENE – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY - 3



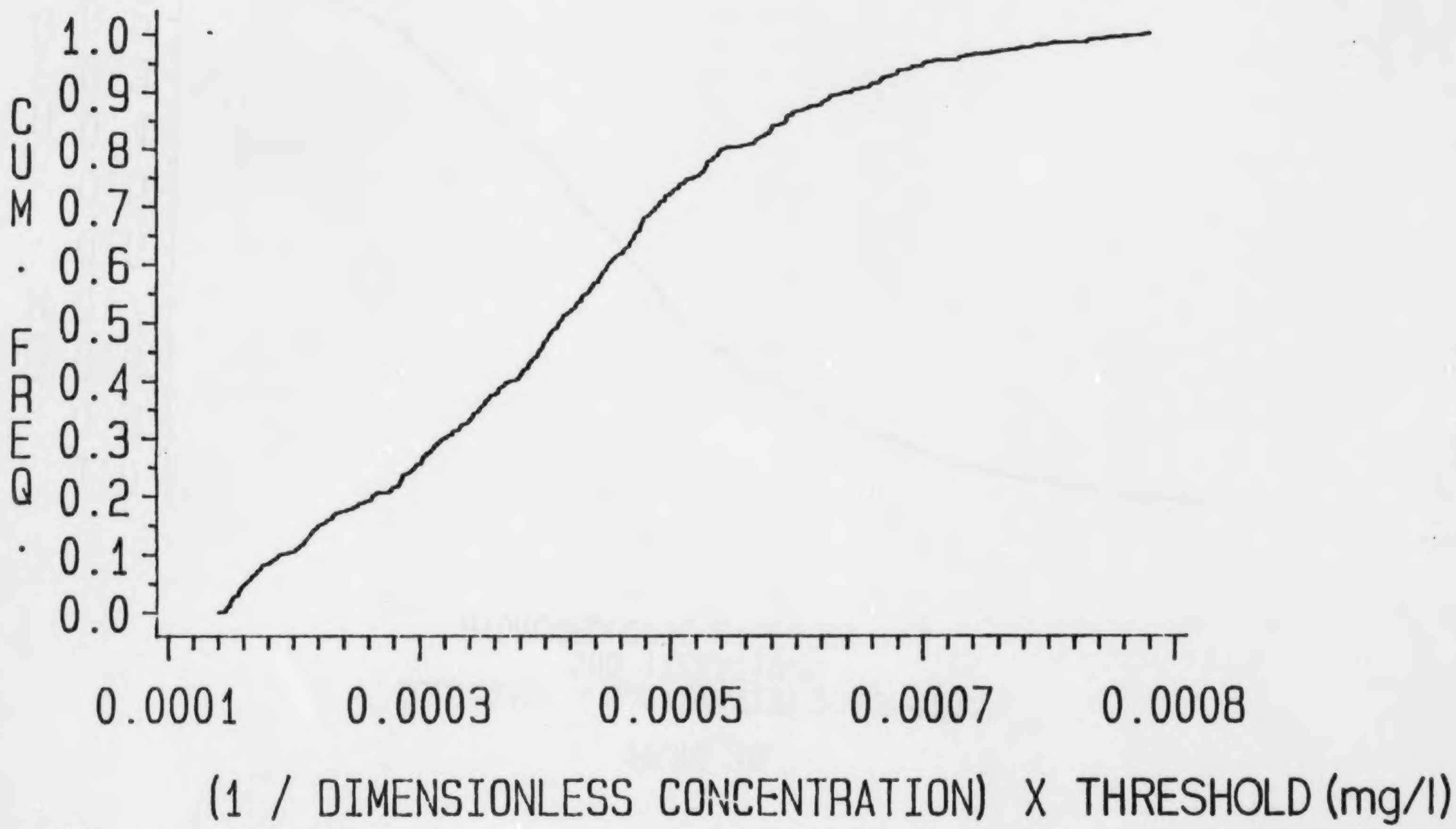
RUN 36

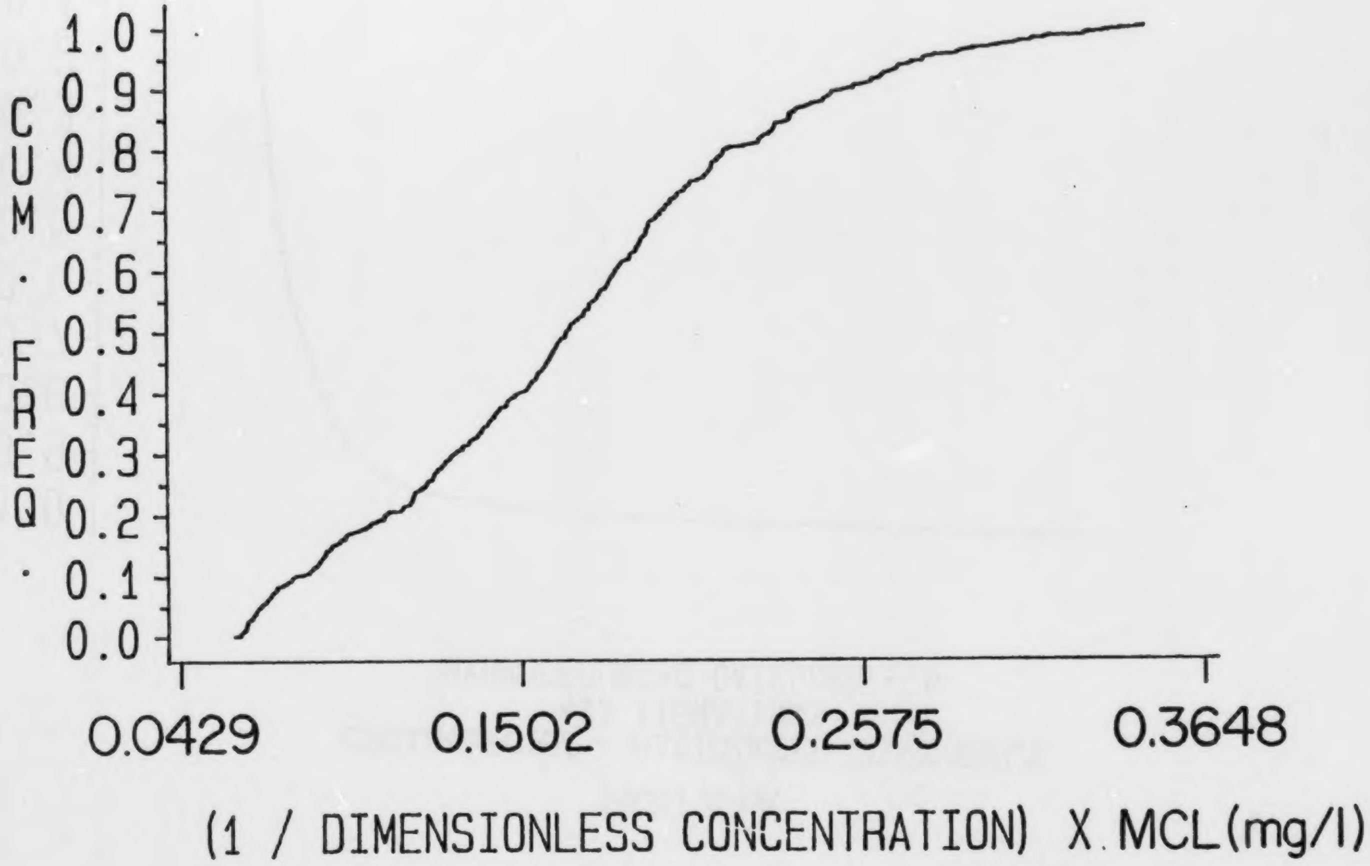
BENZENE – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY – 3



RUN 37

2,4–DINITROTOLUENE – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY - 3



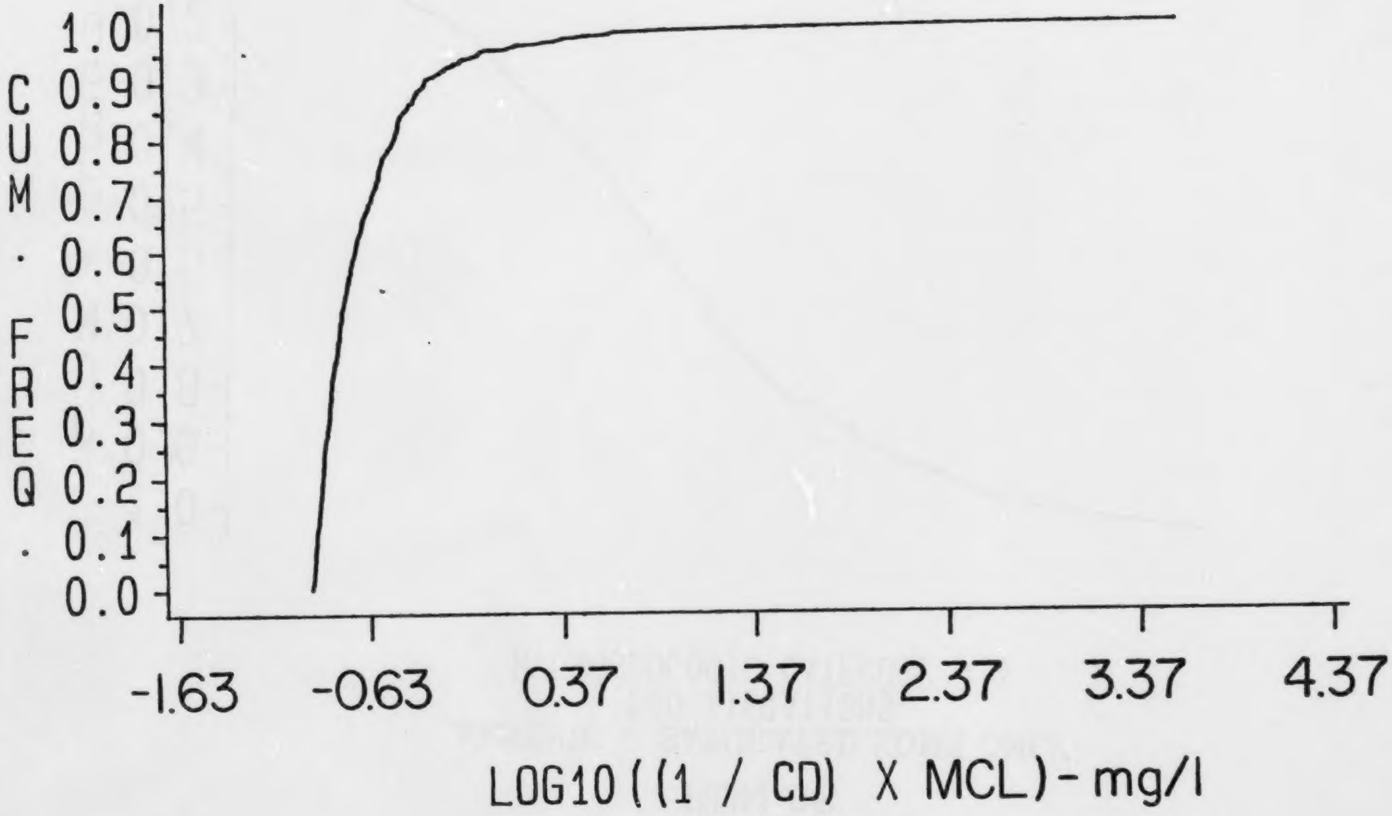


RUN 38

ARSENIC – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY – 3

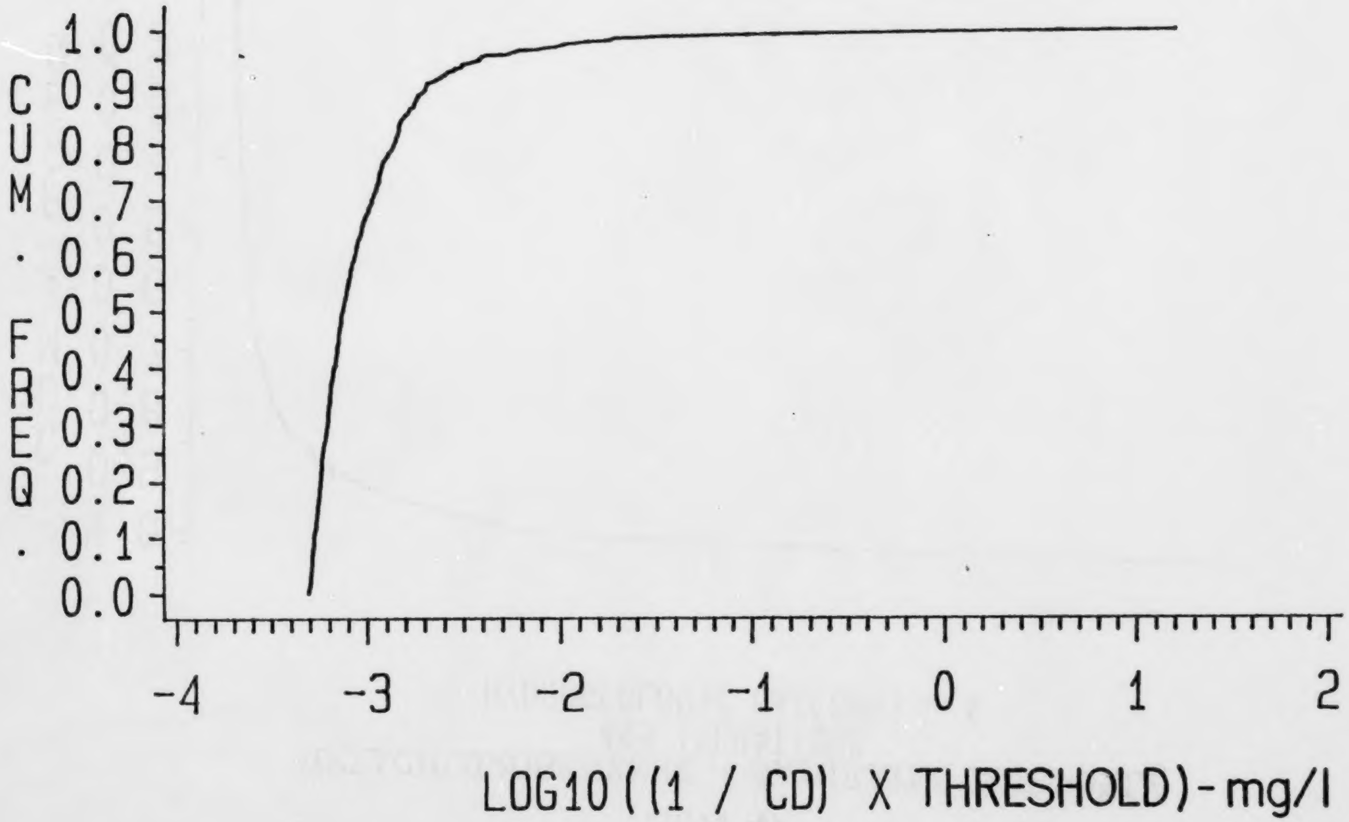
RUN 41A

CHLOROFORM – SATURATED ZONE ONLY
493 ITERATIONS
HYDROGEOLOGIC CATEGORY - 6



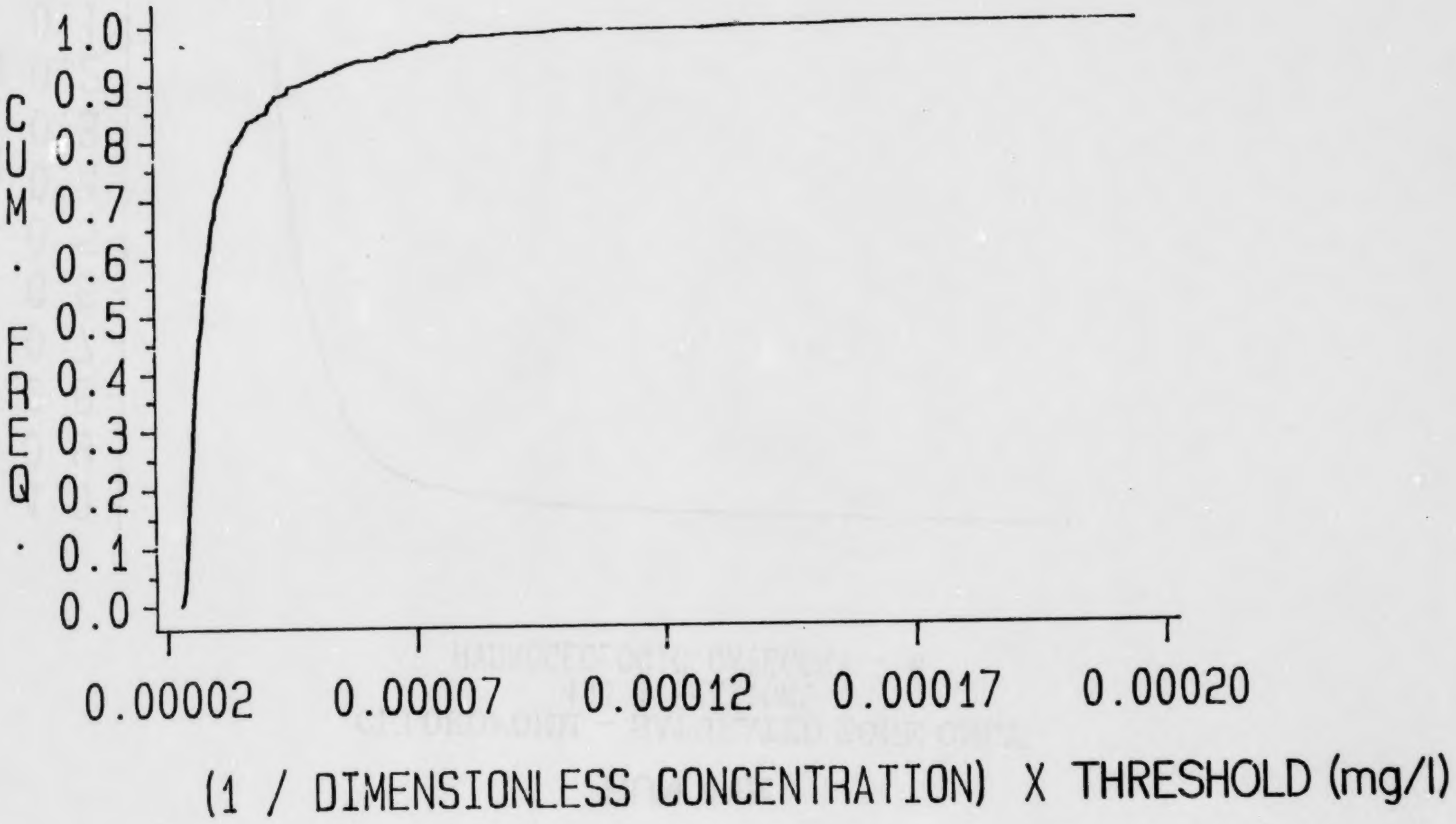
RUN 41B

CHLOROFORM – SATURATED ZONE ONLY
493 ITERATIONS
HYDROGEOLOGIC CATEGORY - 6



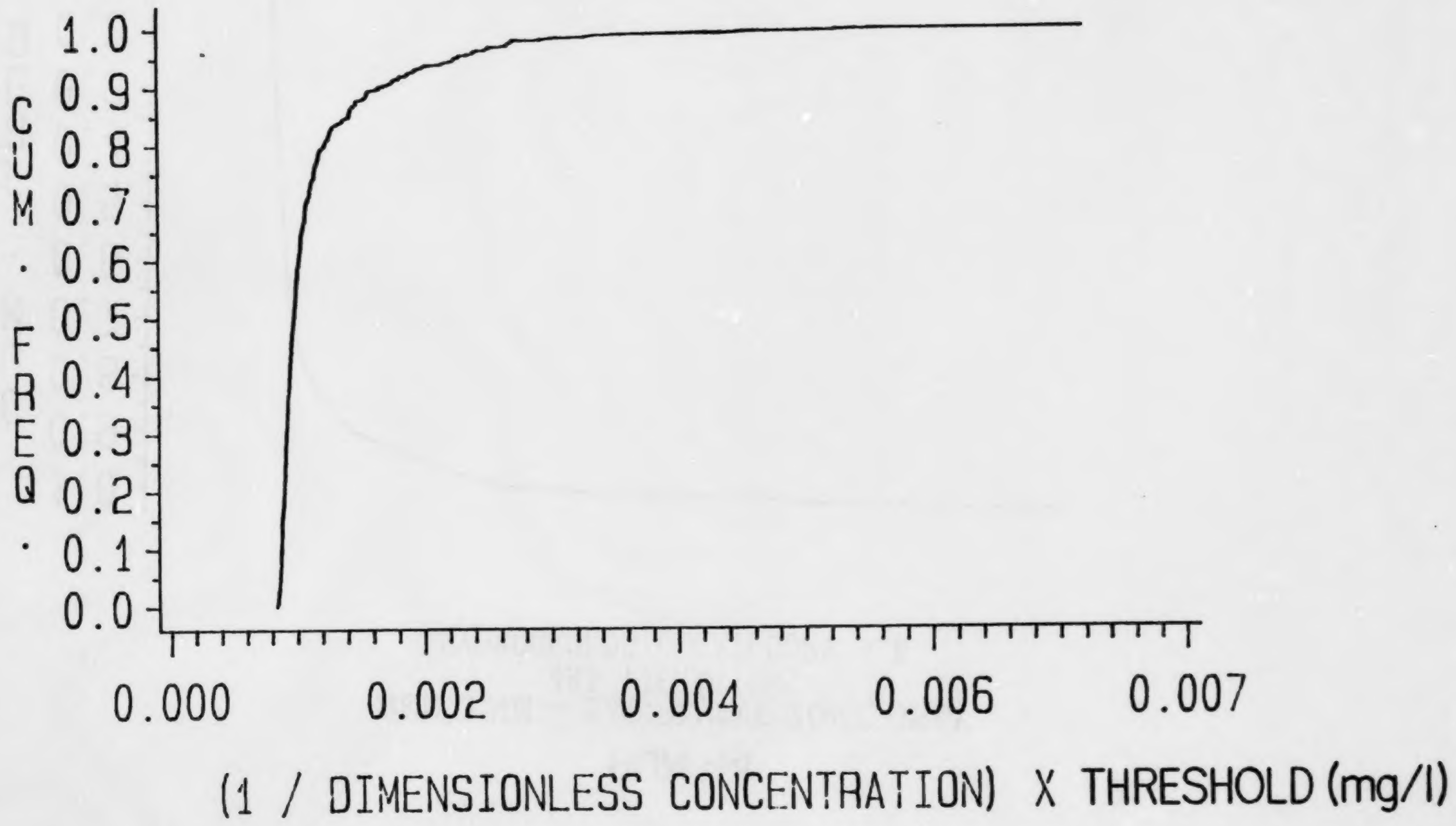
RUN 42

HEXACHLOROBENZENE – SATURATED ZONE ONLY
493 ITERATIONS
HYDROGEOLOGIC CATEGORY - 6



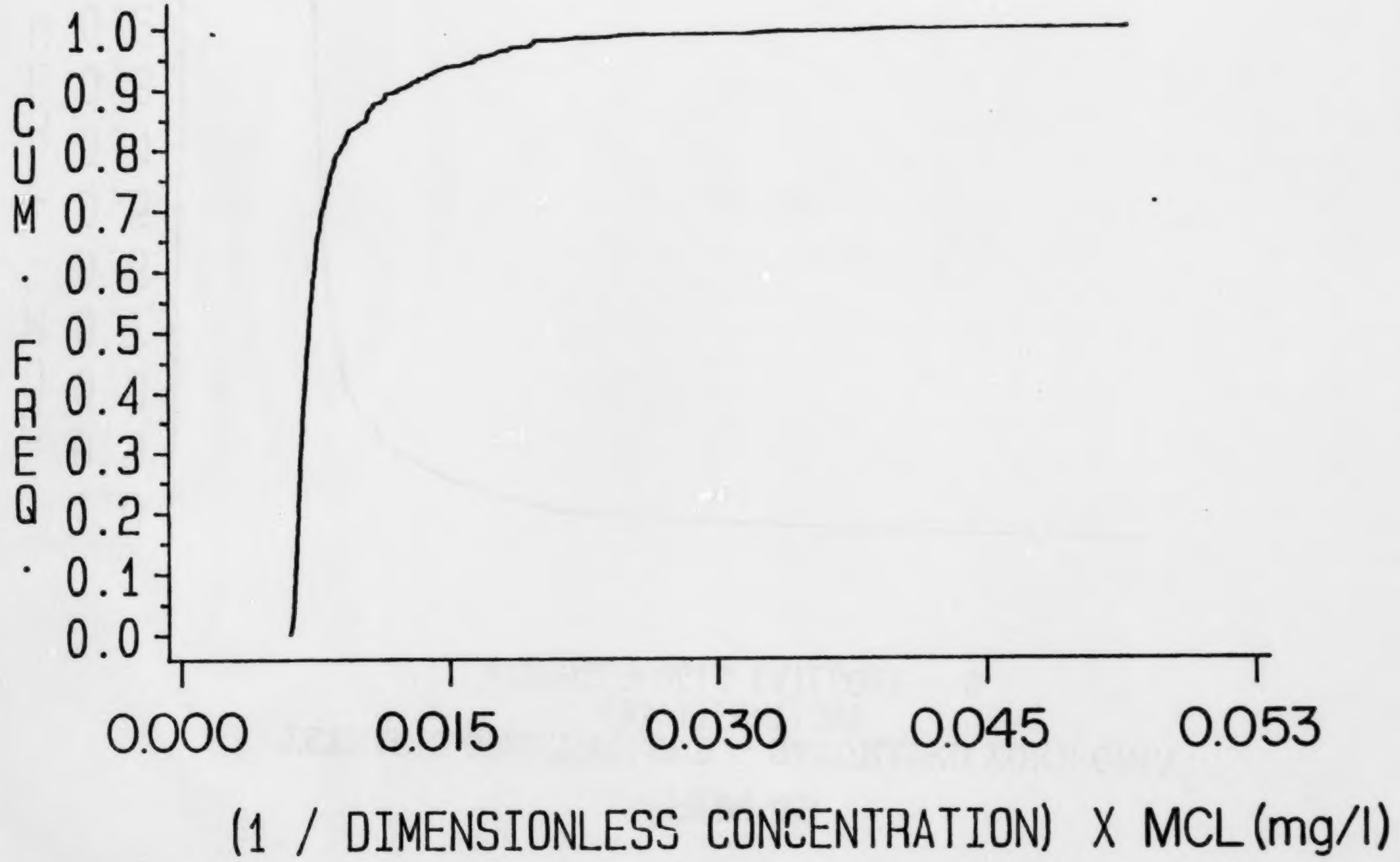
RUN 43

TETRACHLOROETHYLENE – SATURATED ZONE ONLY
493 ITERATIONS
HYDROGEOLOGIC CATEGORY – 6



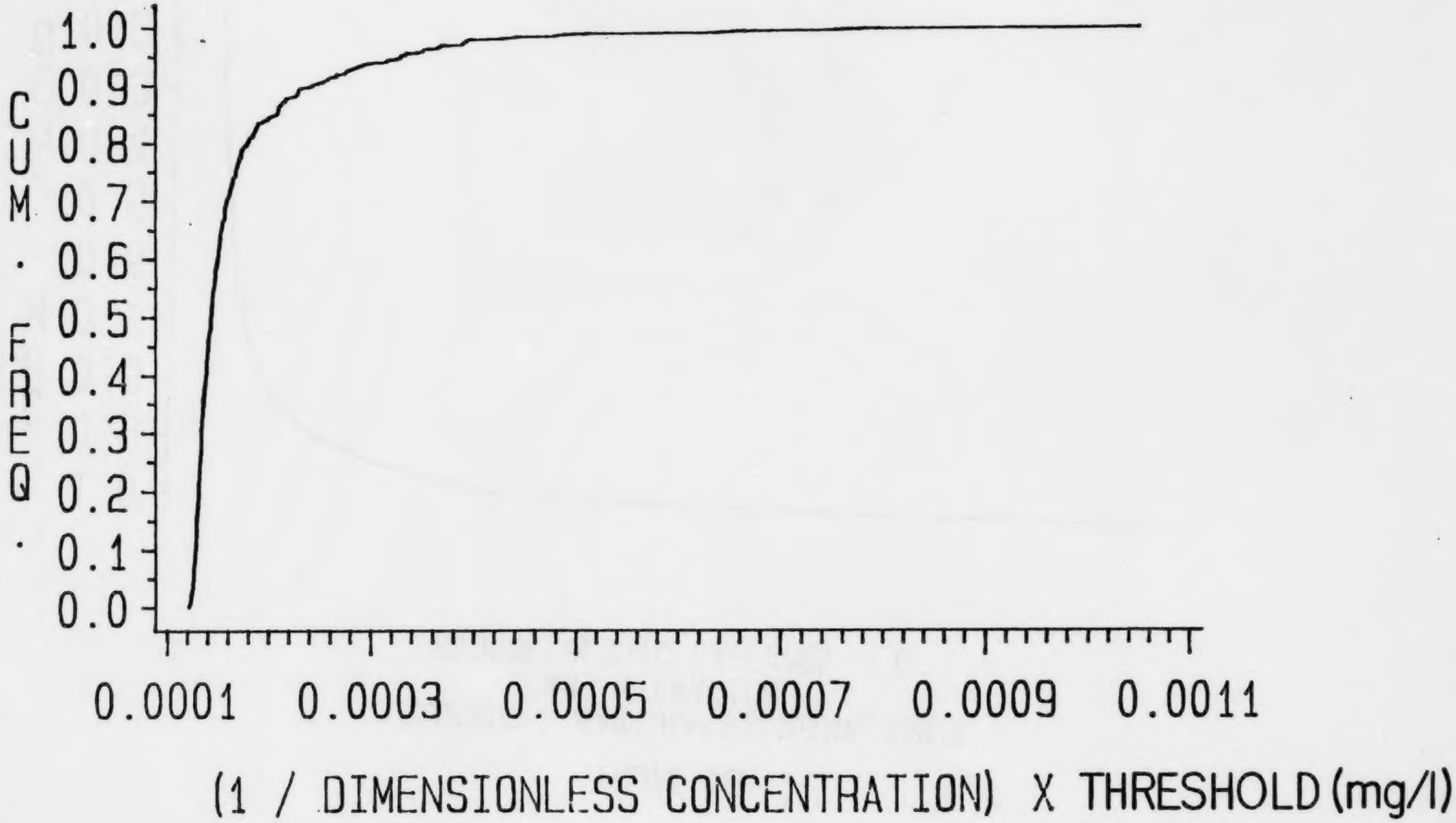
RUN 44

BENZENE – SATURATED ZONE ONLY
493 ITERATIONS
HYDROGEOLOGIC CATEGORY – 6



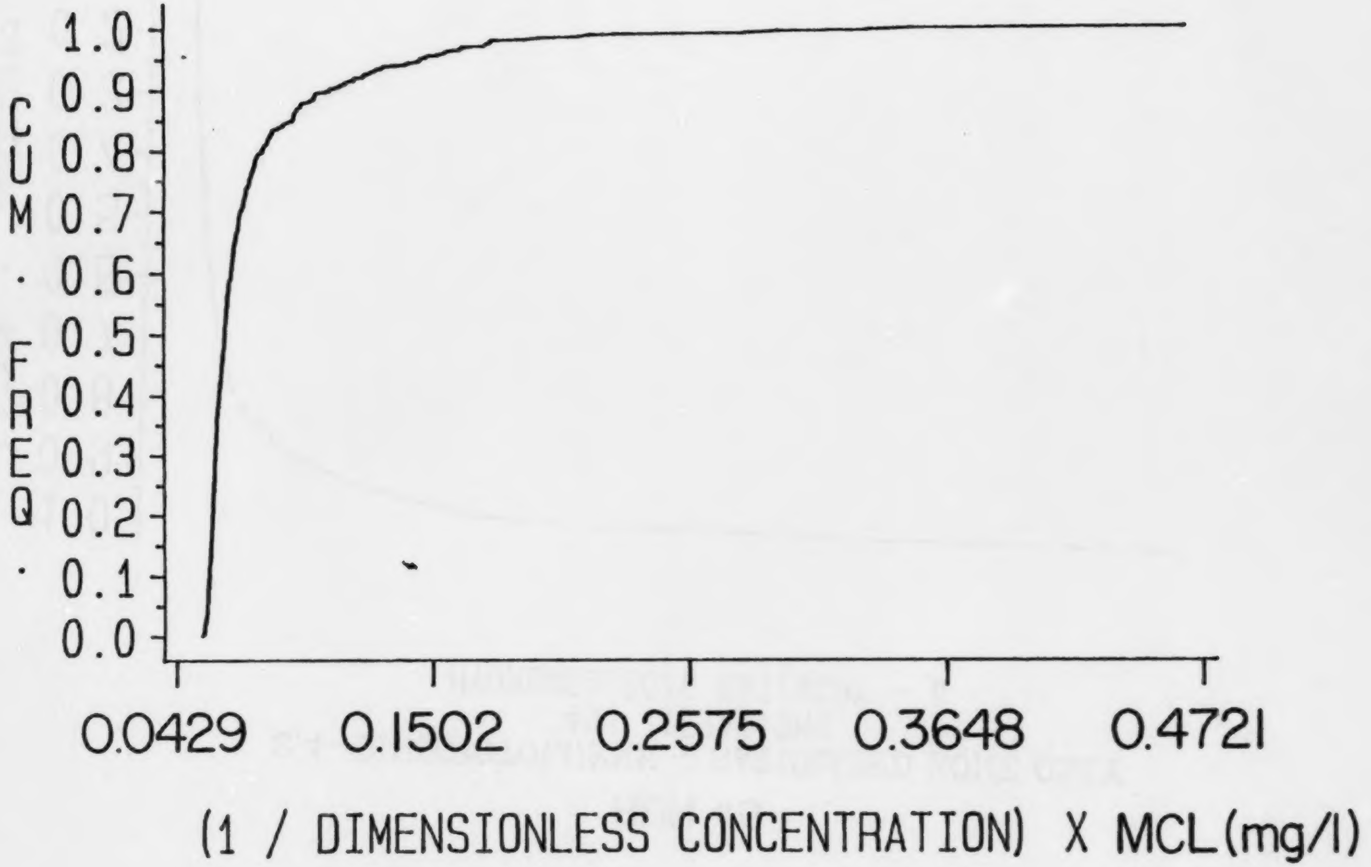
RUN 45

2,4–DINITROTOLUENE – SATURATED ZONE ONLY
493 ITERATIONS
HYDROGEOLOGIC CATEGORY – 6



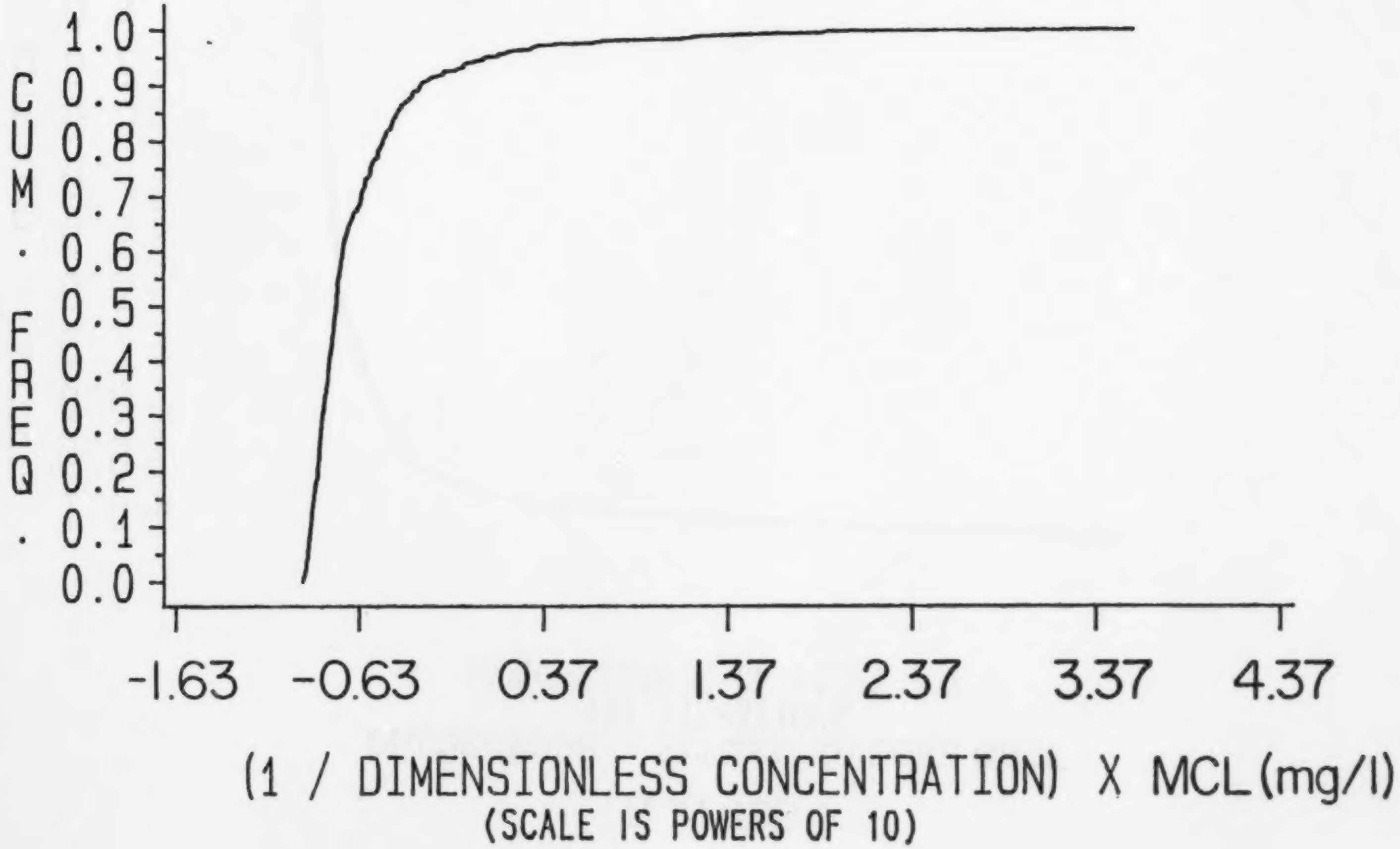
RUN 46

ARSENIC – SATURATED ZONE ONLY
493 ITERATIONS
HYDROGEOLOGIC CATEGORY – 6



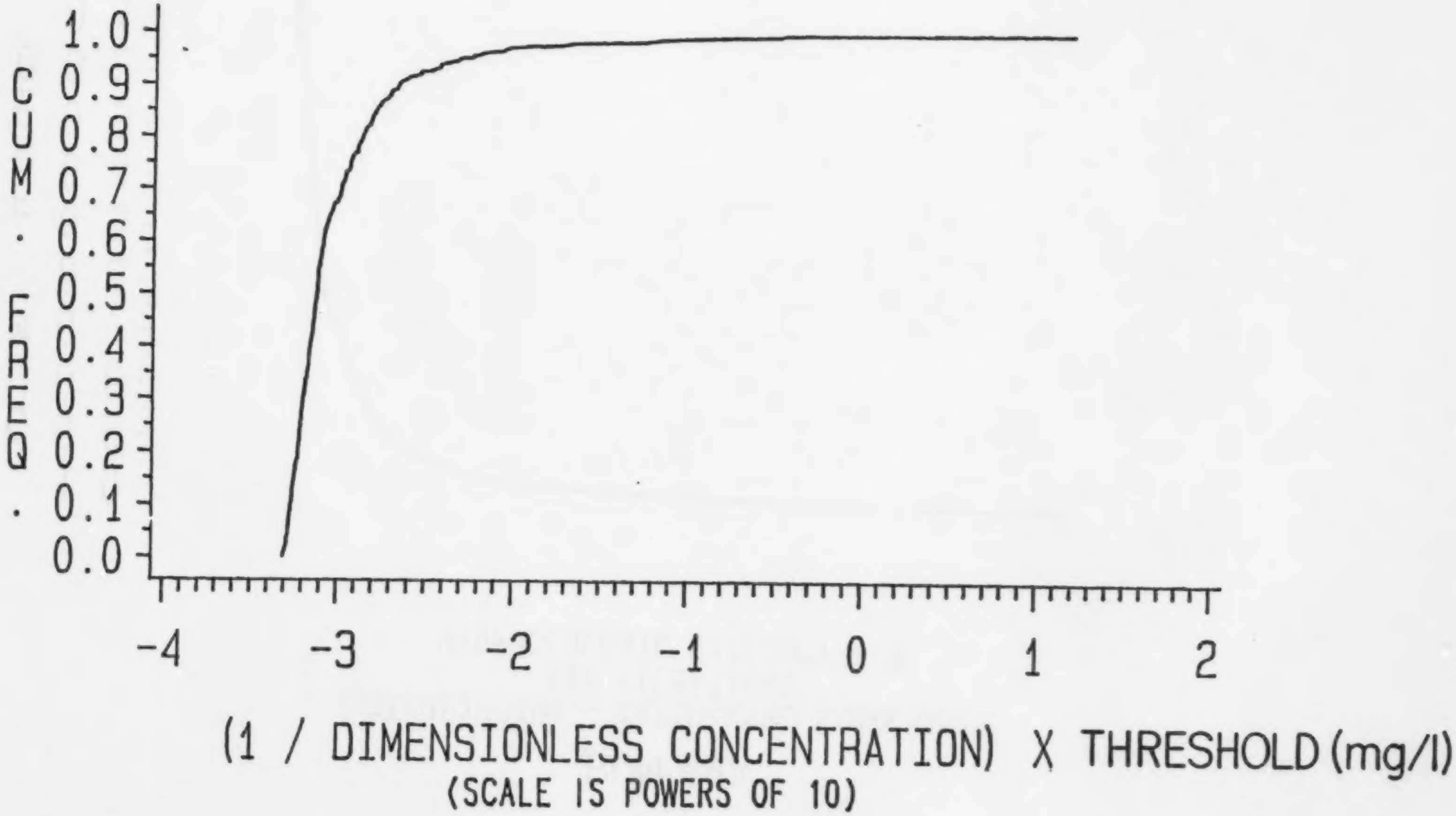
RUN 49A

CHLOROFORM – SATURATED ZONE ONLY
497 ITERATIONS
HYDROGEOLOGIC CATEGORY - 7



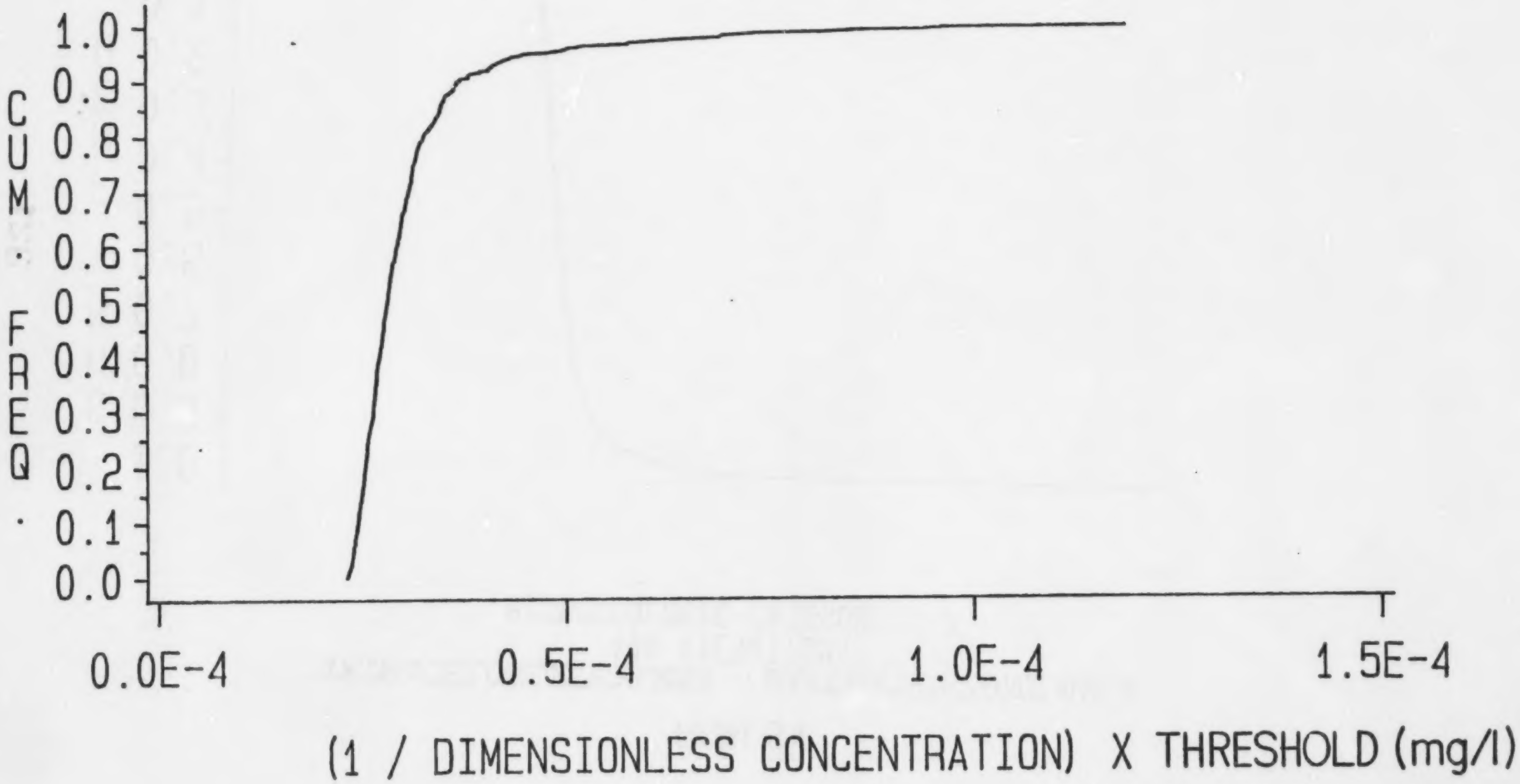
RUN 49B

CHLOROFORM – SATURATED ZONE ONLY
497 ITERATIONS
HYDROGEOLOGIC CATEGORY - 7



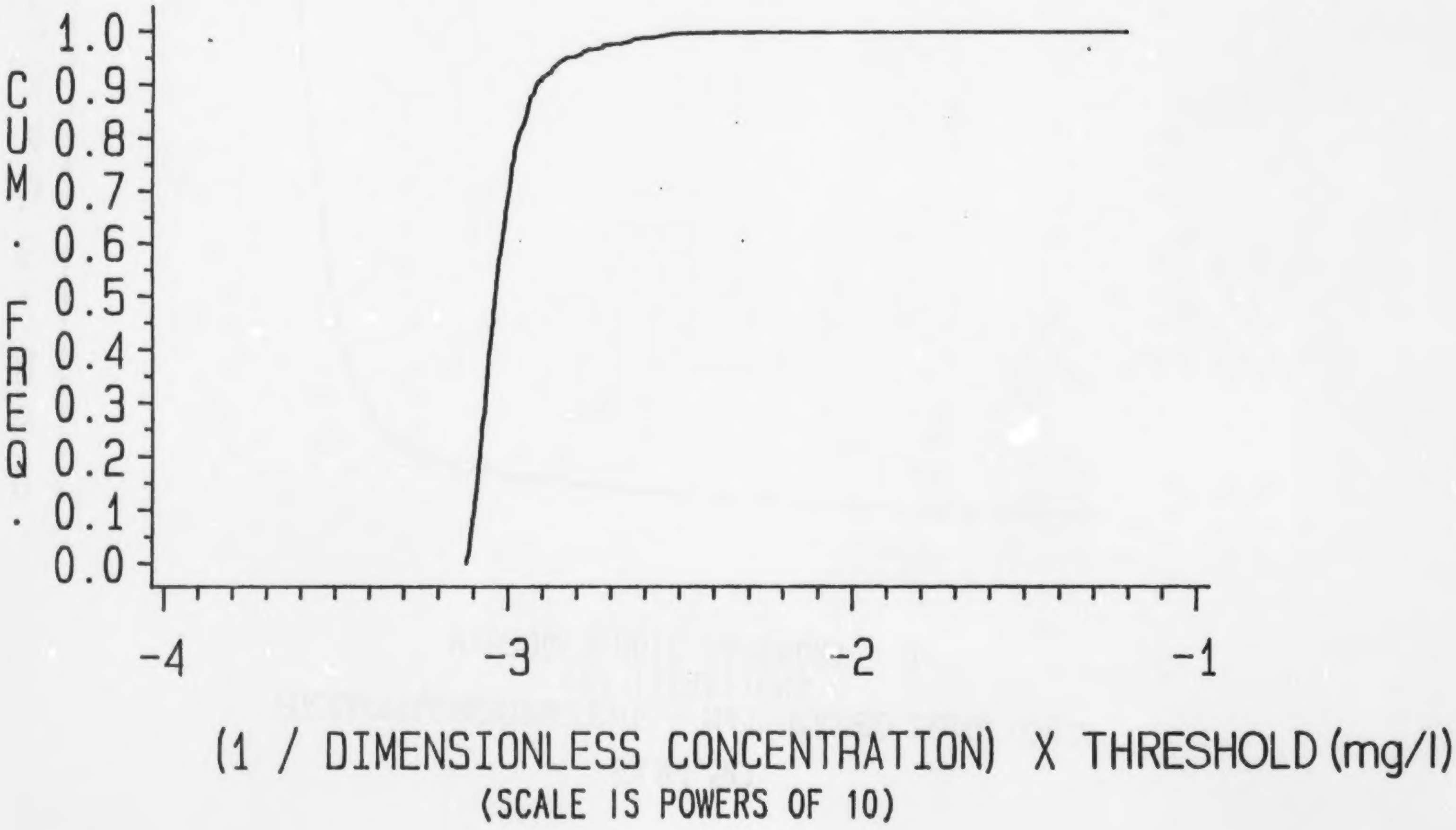
RUN 50

HEXACHLOROBENZENE – SATURATED ZONE ONLY
497 ITERATIONS
HYDROGEOLOGIC CATEGORY - 7



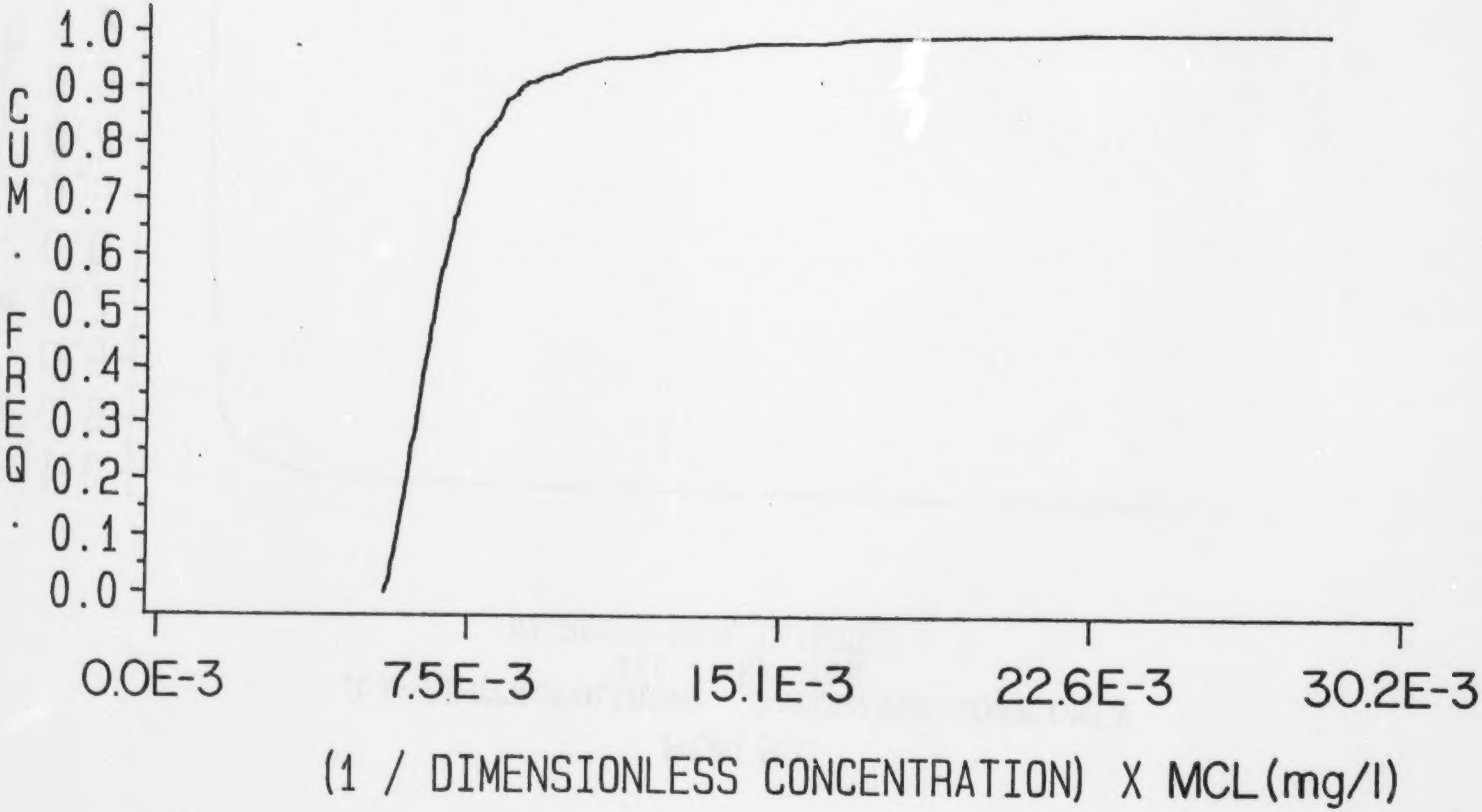
RUN 51

TETRACHLOROETHYLENE – SATURATED ZONE ONLY
498 ITERATIONS
HYDROGEOLOGIC CATEGORY – 7



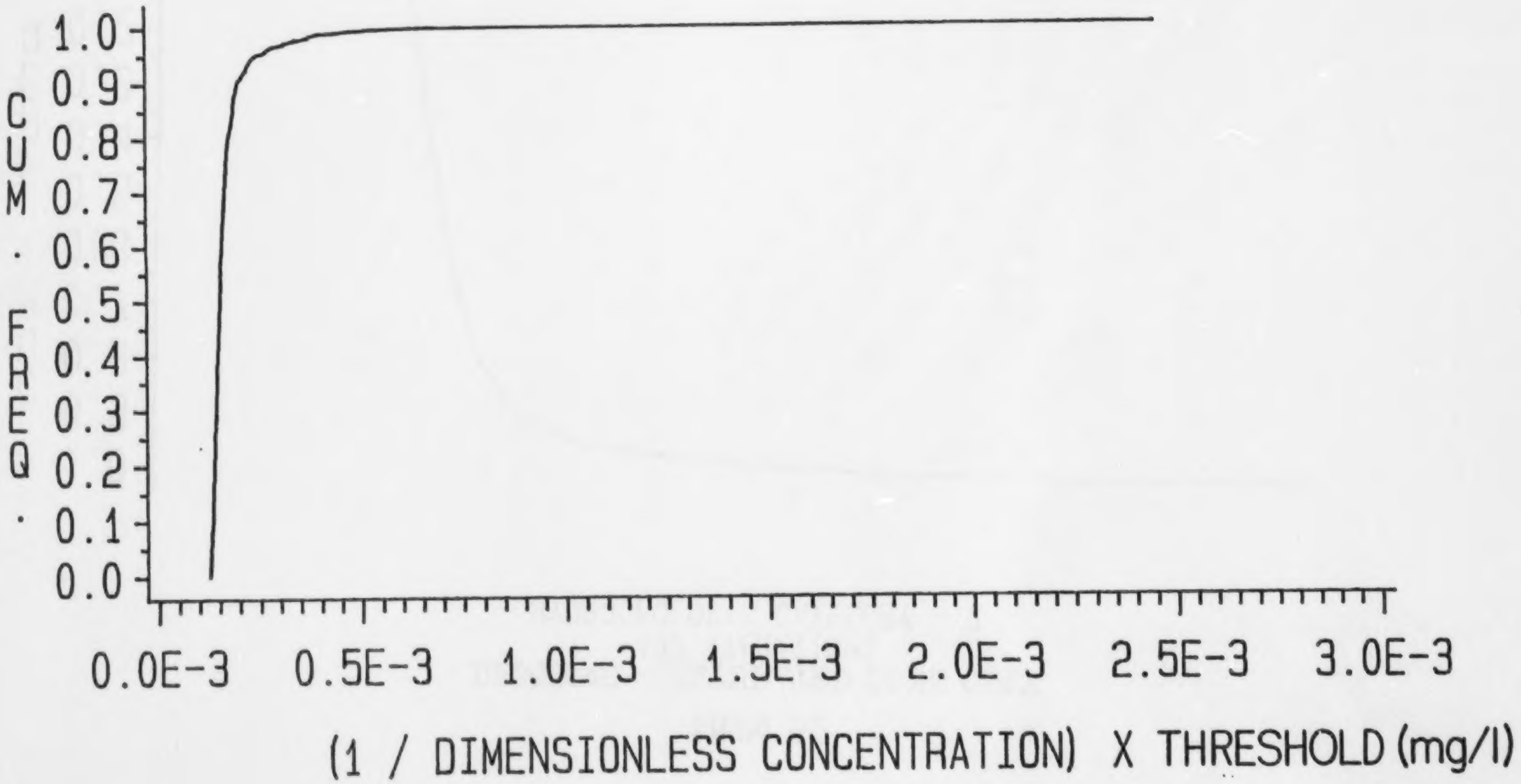
RUN 52

BENZENE – SATURATED ZONE ONLY
497 ITERATIONS
HYDROGEOLOGIC CATEGORY - 7



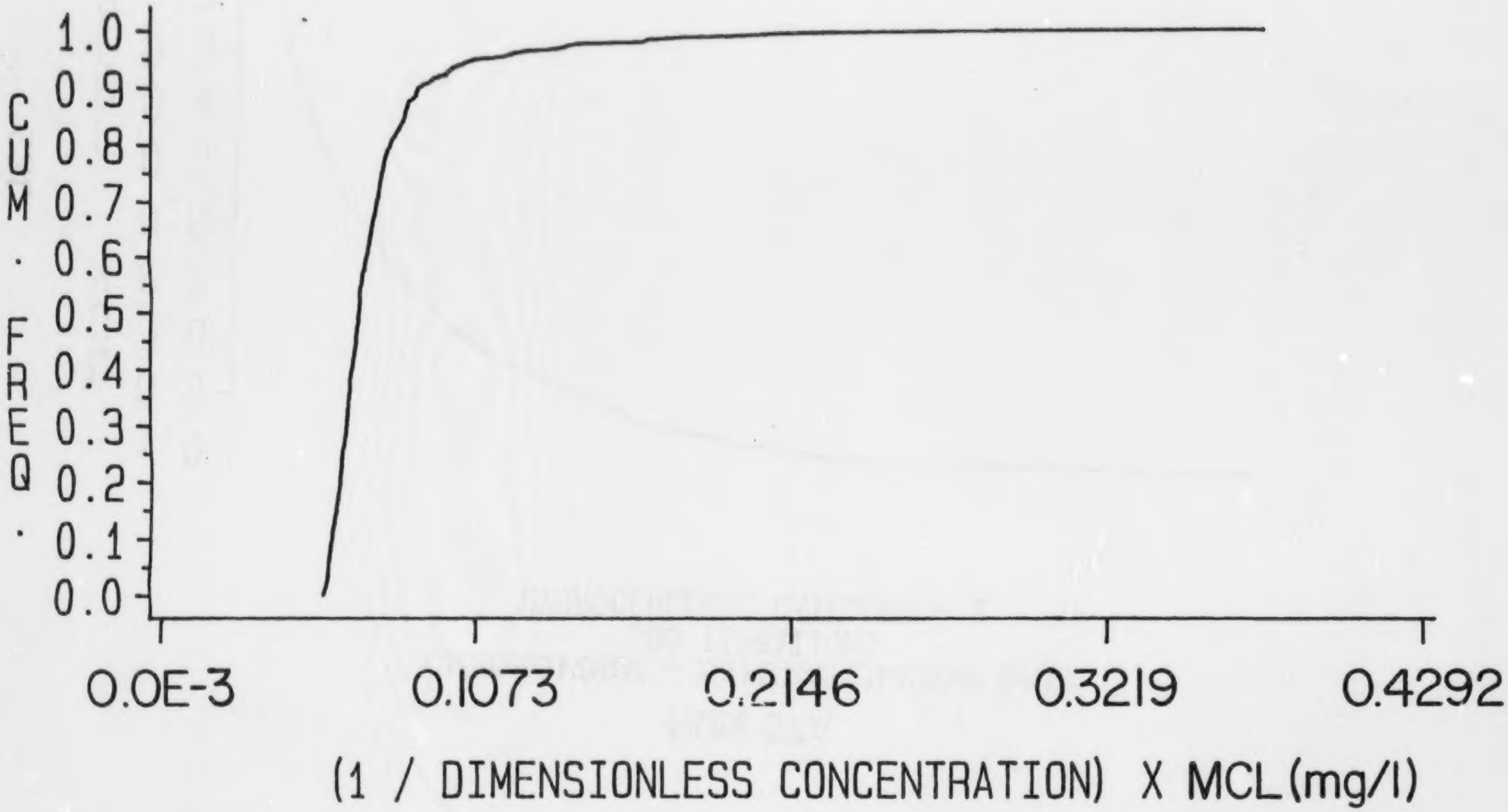
RUN 53

2,4-DINITROTOLUENE – SATURATED ZONE ONLY
498 ITERATIONS
HYDROGEOLOGIC CATEGORY - 7



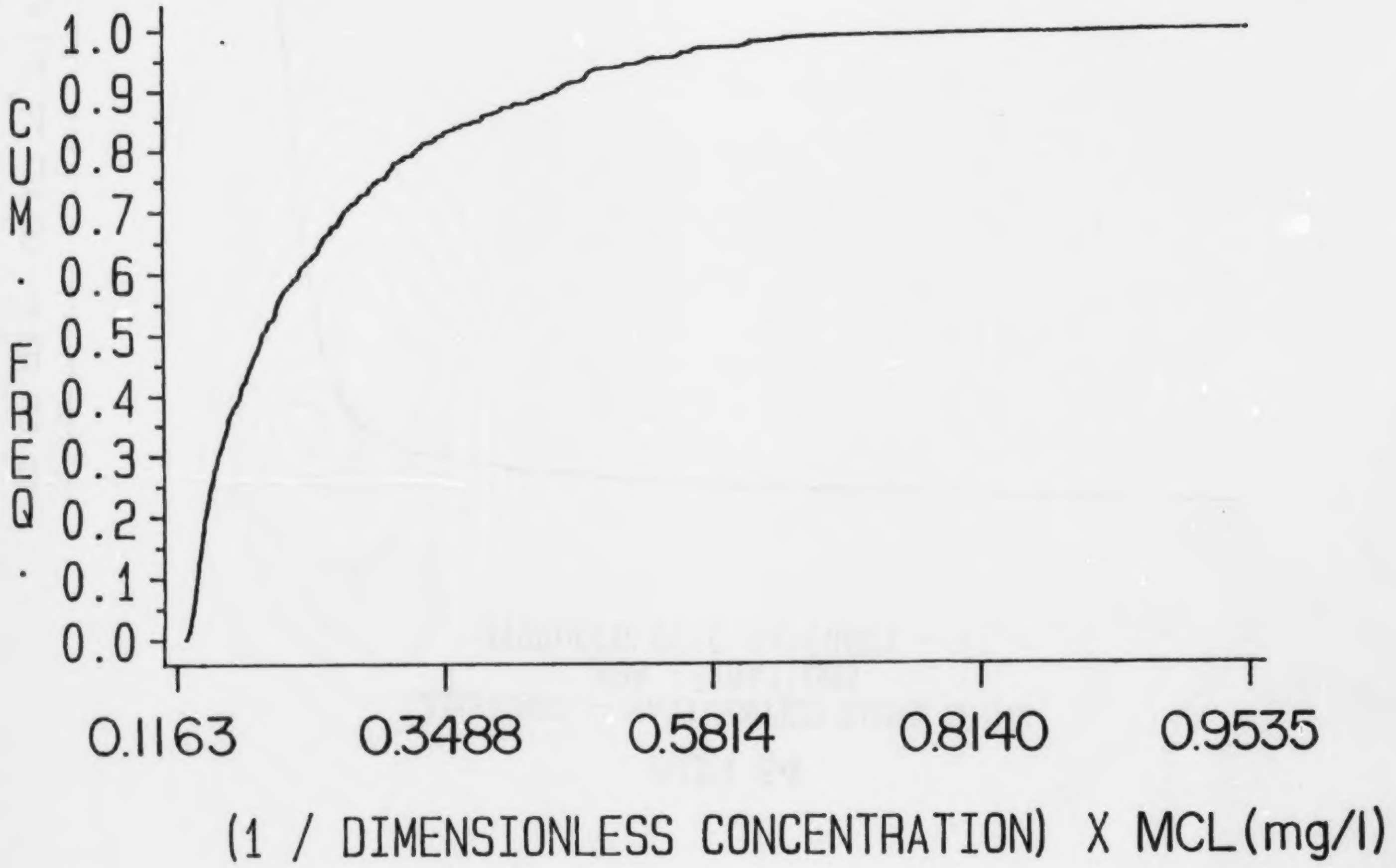
RUN 54

ARSENIC – SATURATED ZONE ONLY
498 ITERATIONS
HYDROGEOLOGIC CATEGORY - 7



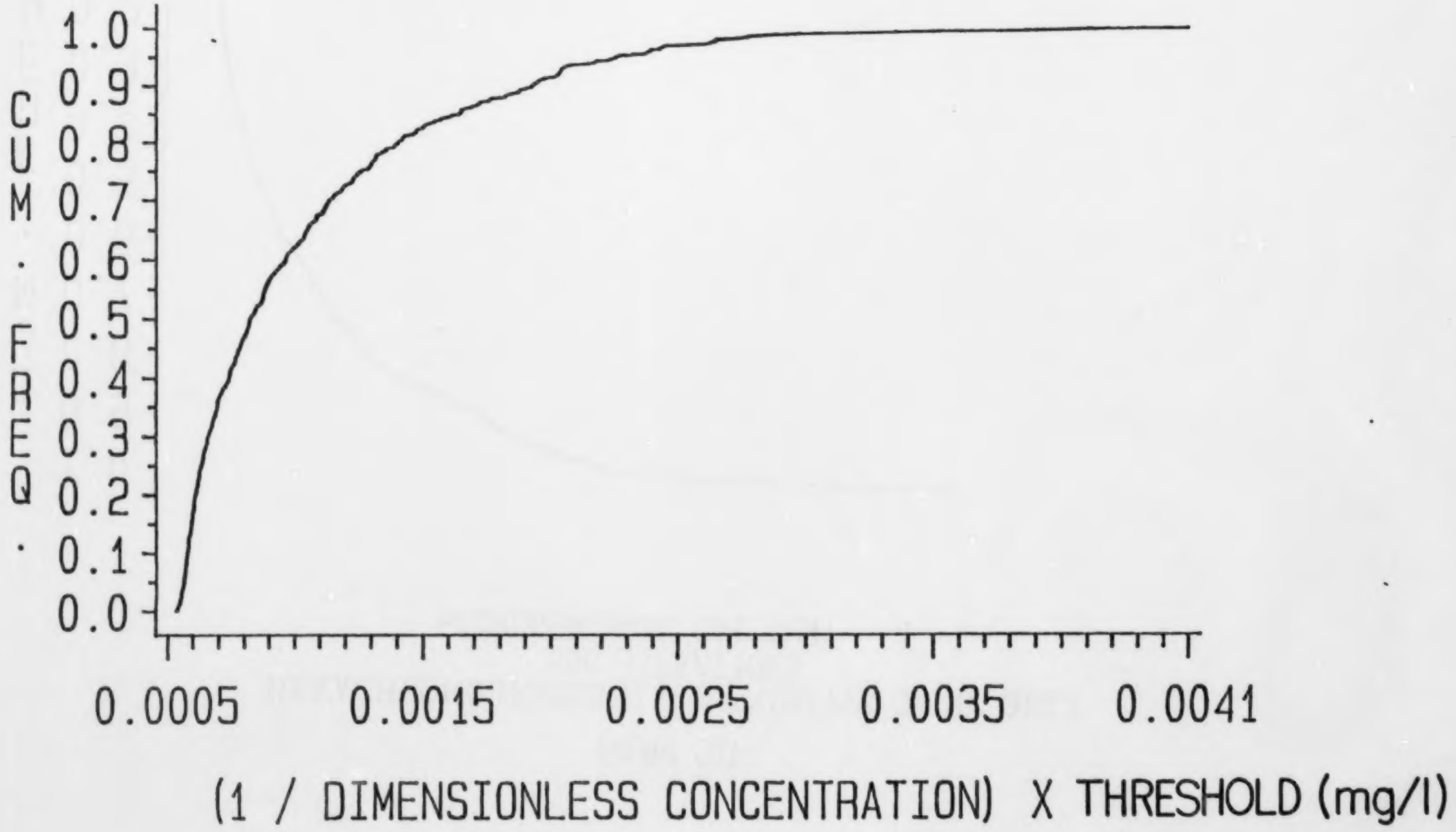
RUN 57A

CHLOROFORM – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY - 8



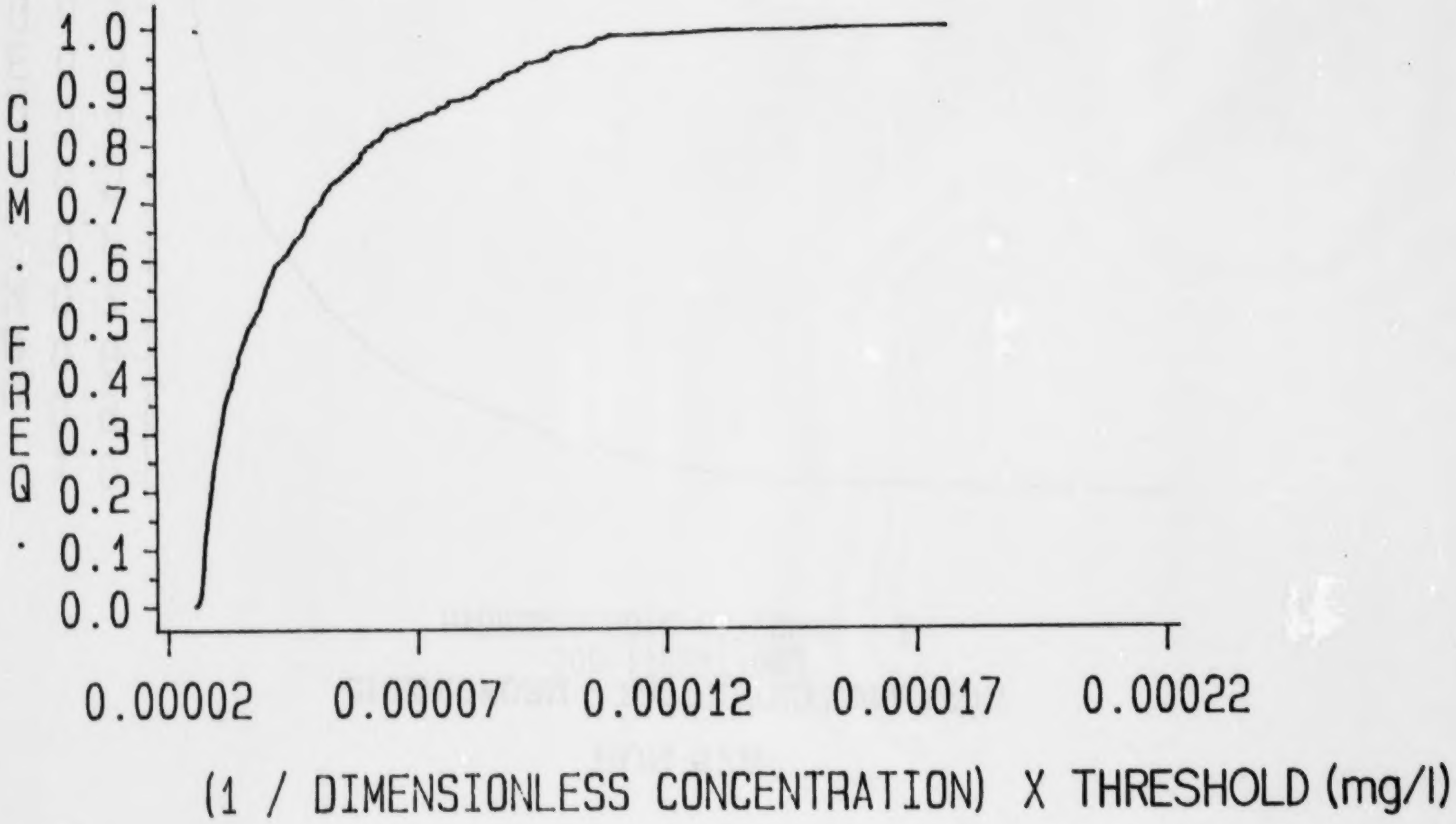
RUN 57B

CHLOROFORM – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY - 8



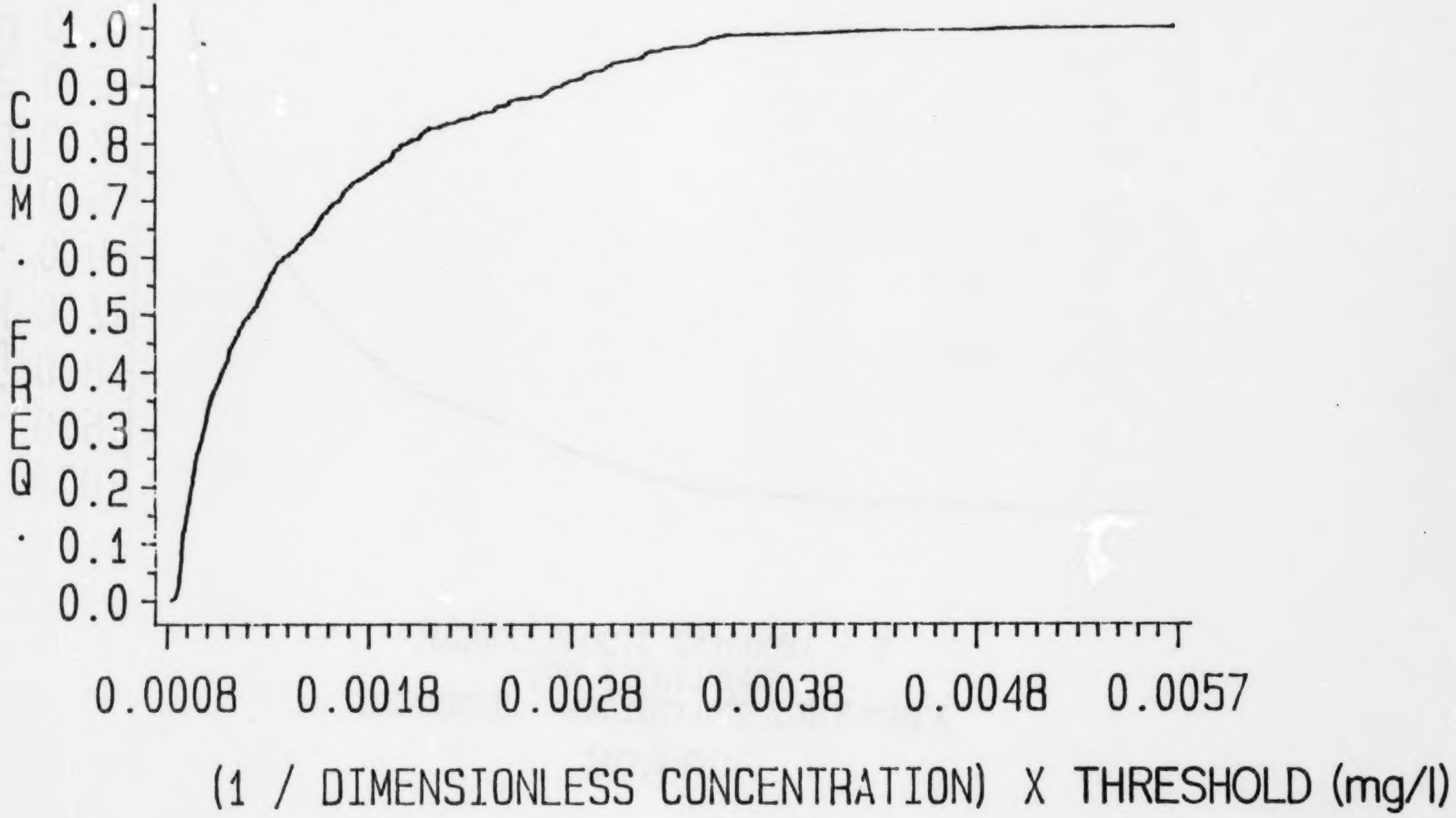
RUN 58

HEXACHLOROBENZENE – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY - 8



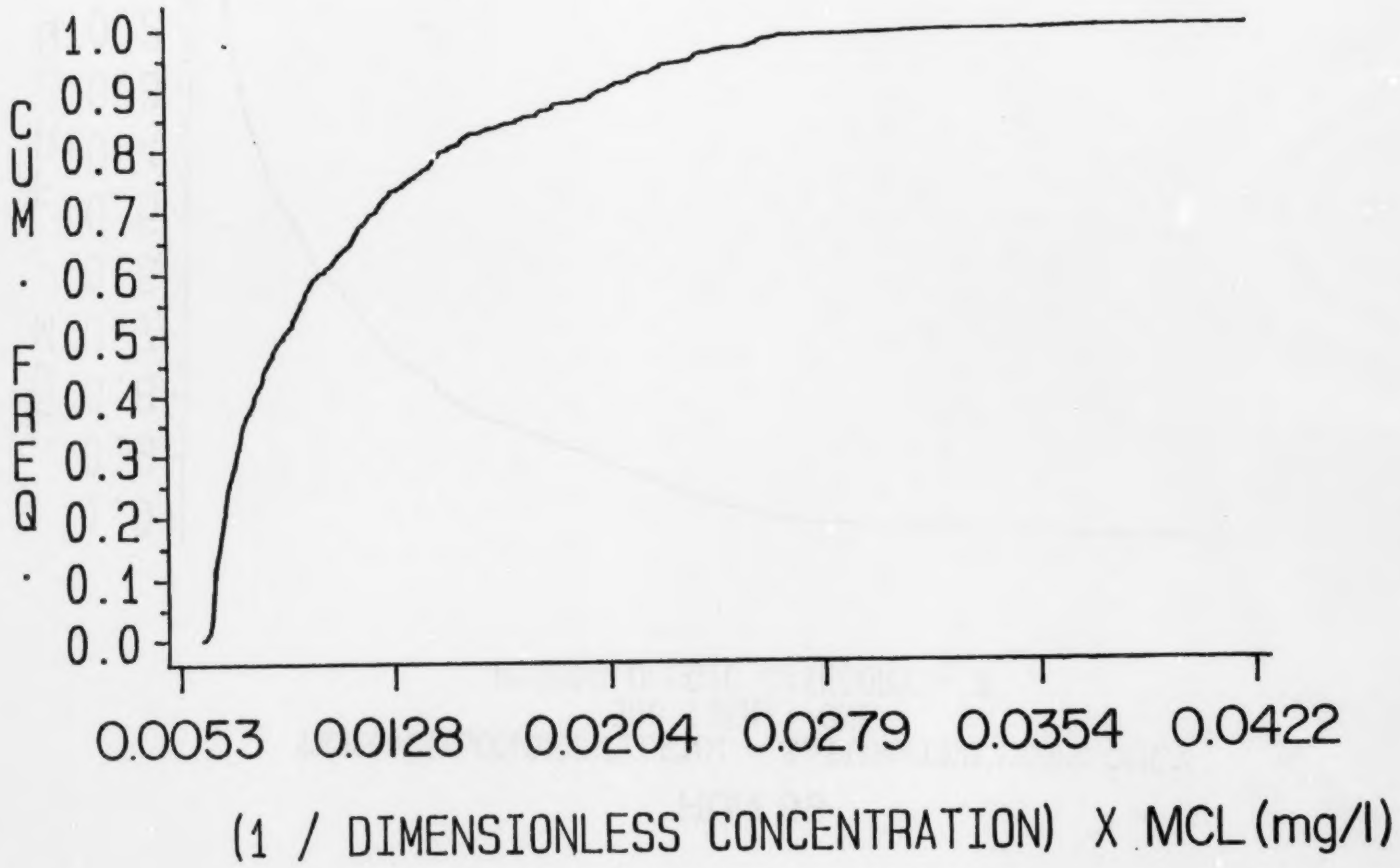
RUN 59

TETRACHLOROETHYLENE – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY - 8



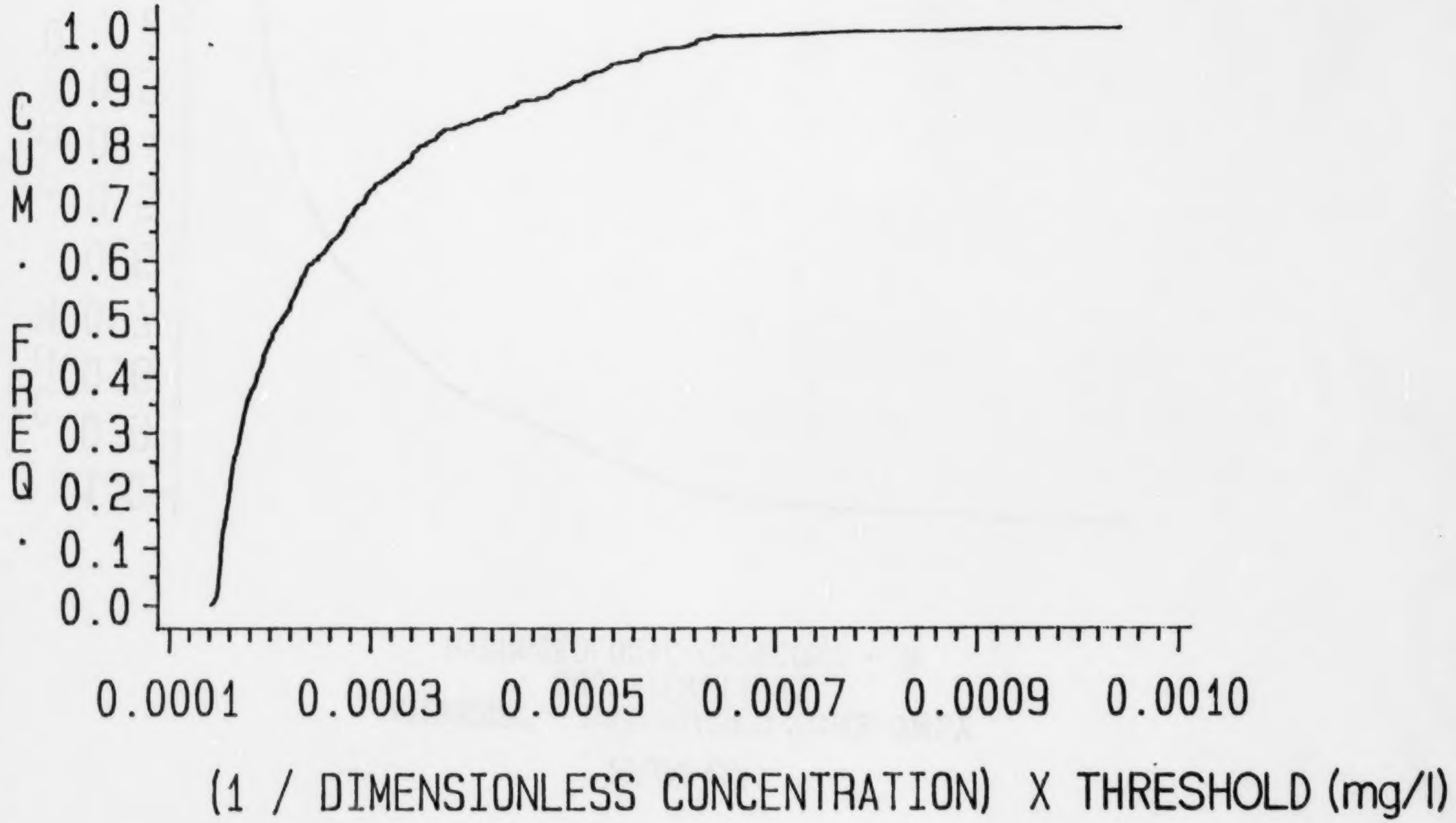
RUN 60

BENZENE – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY - 8



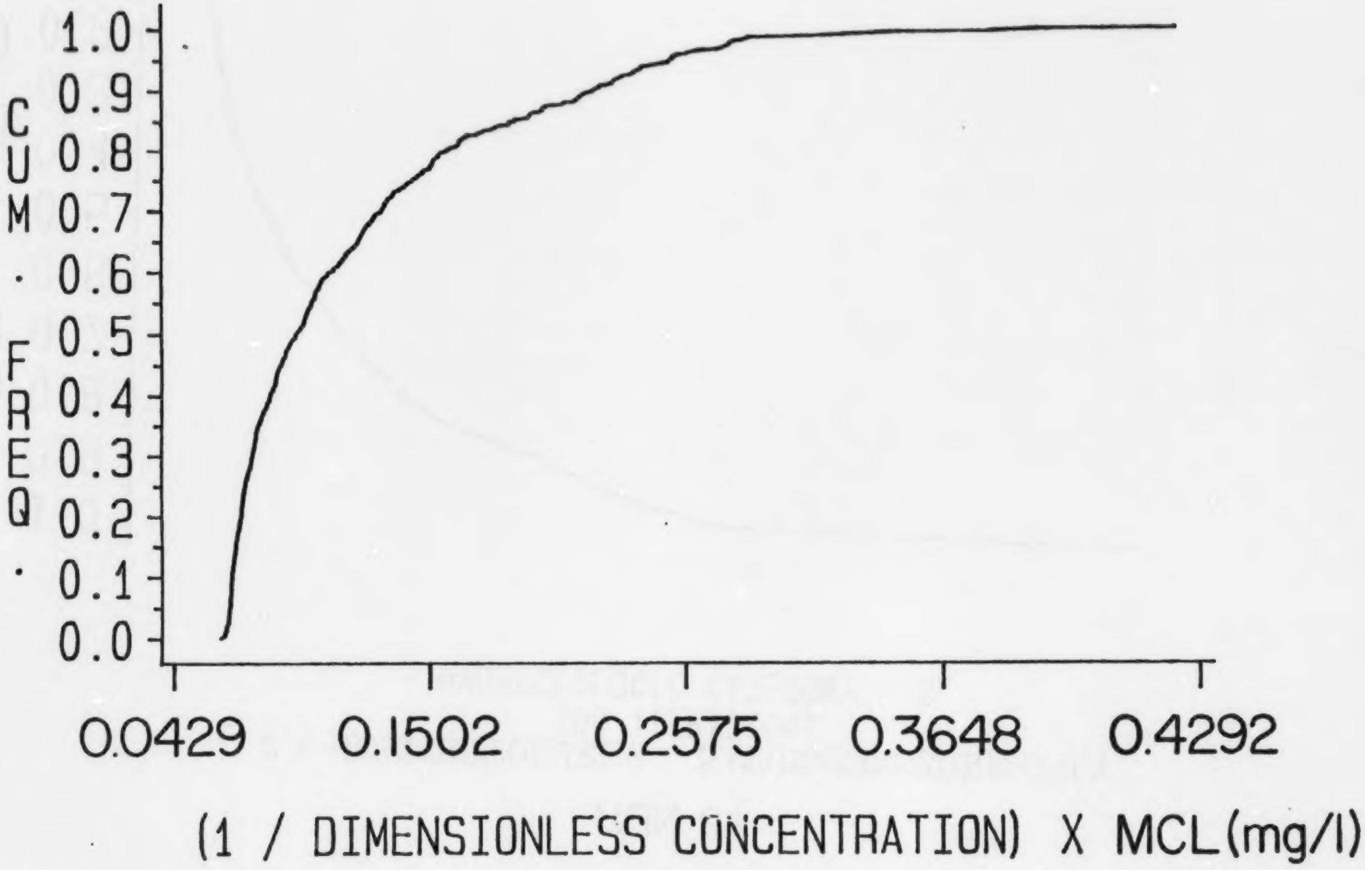
RUN 61

2,4-DINITROTOLUENE – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY – 8



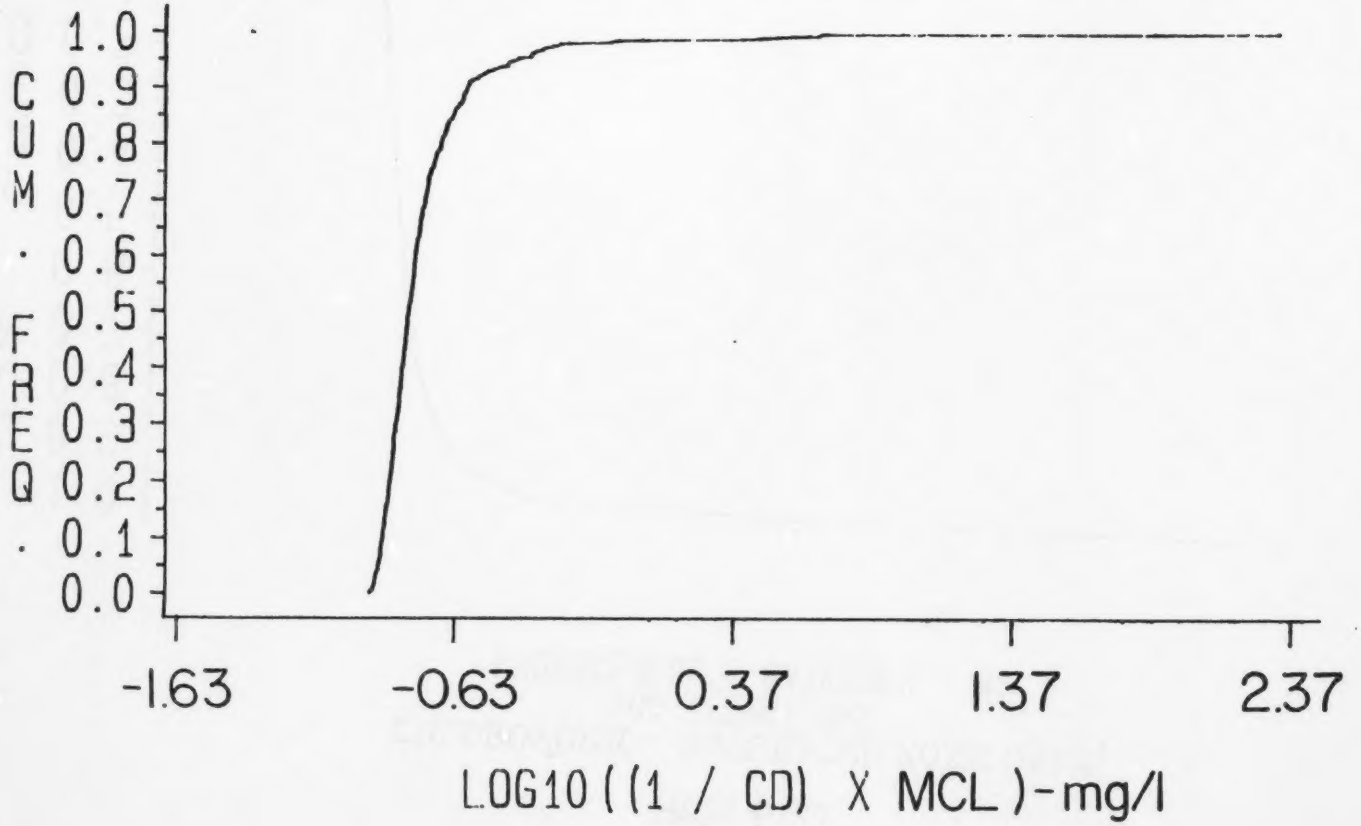
RUN 62

ARSENIC – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY - 8



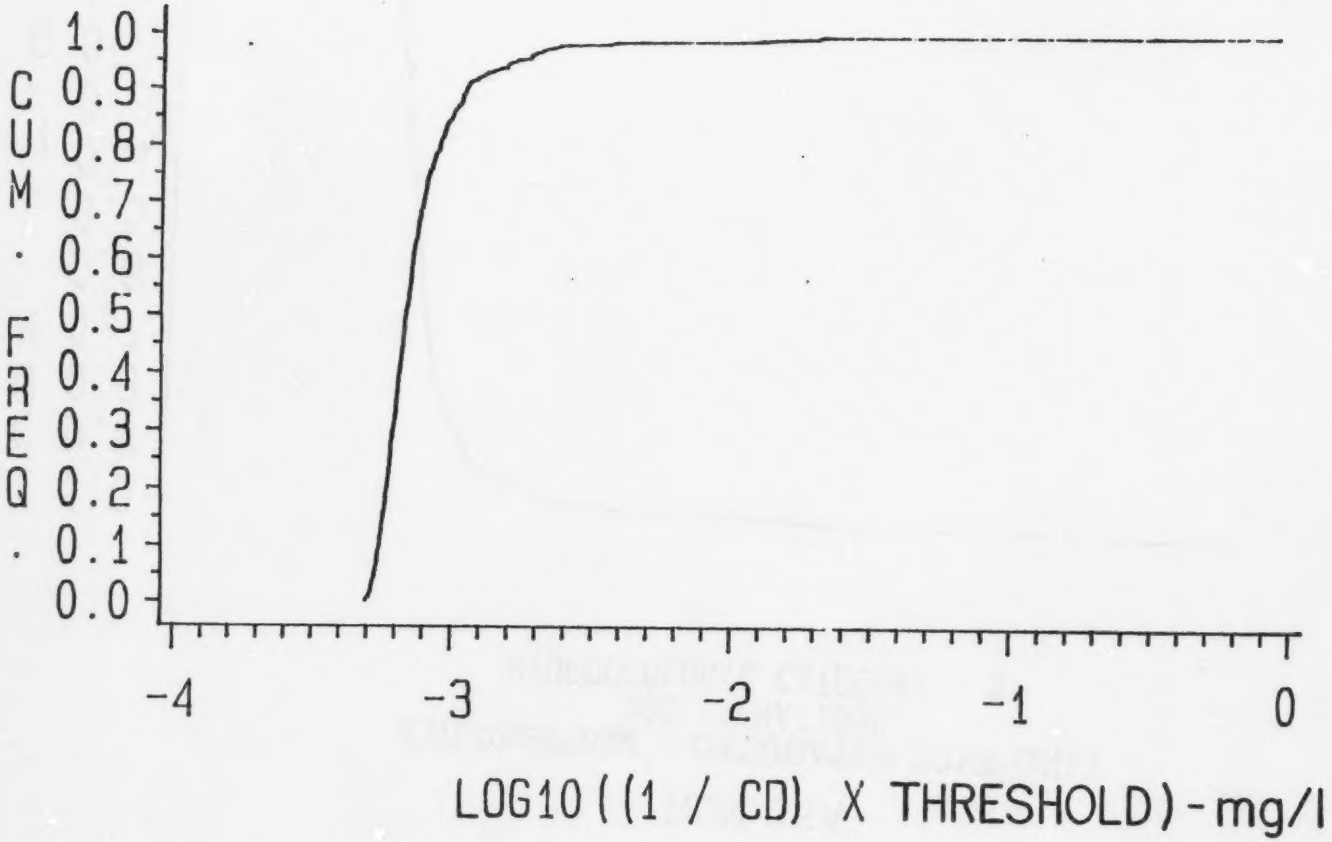
RUN 65A

CHLOROFORM – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY – 9



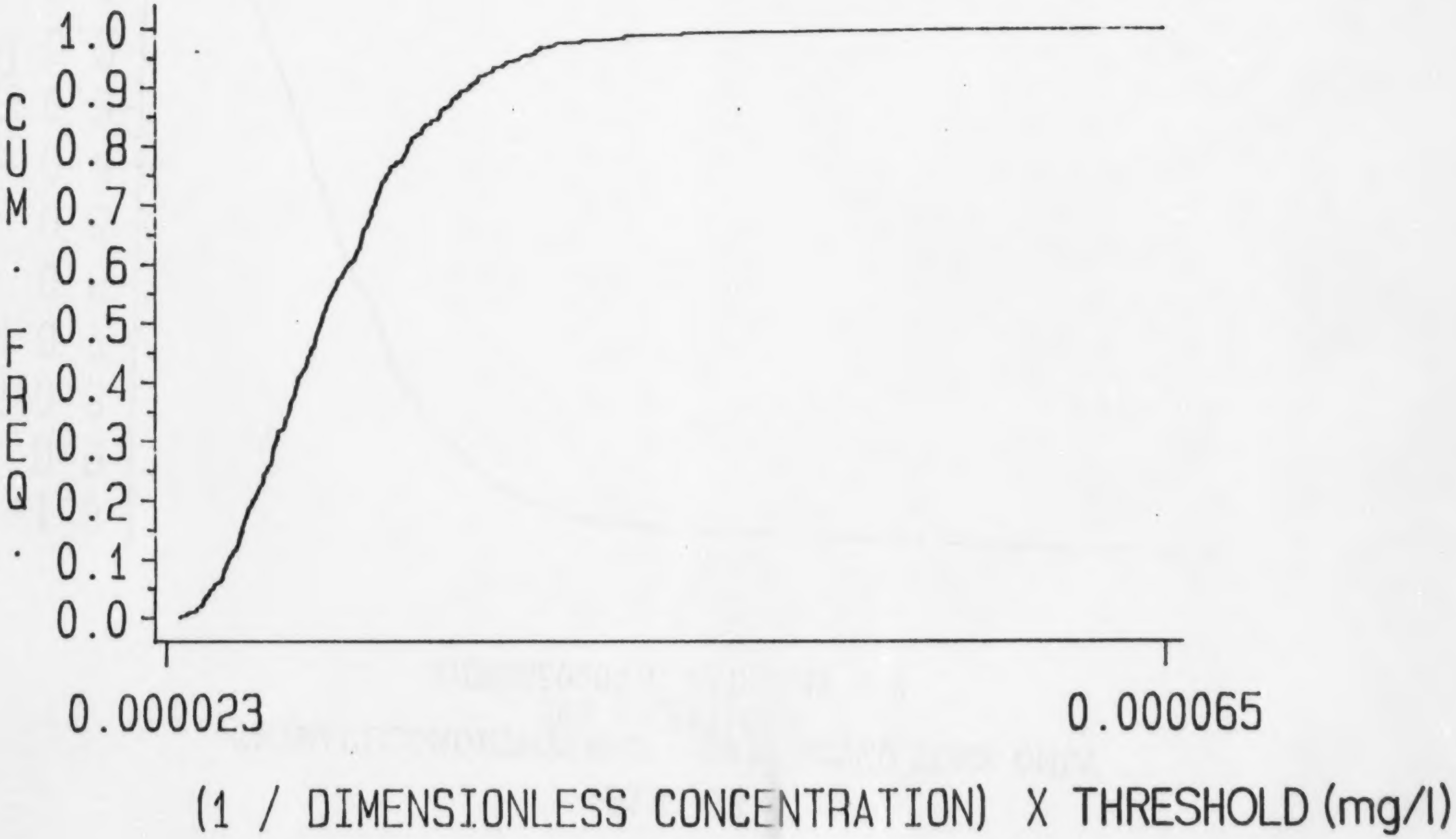
RUN 65B

CHLOROFORM – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY – 9



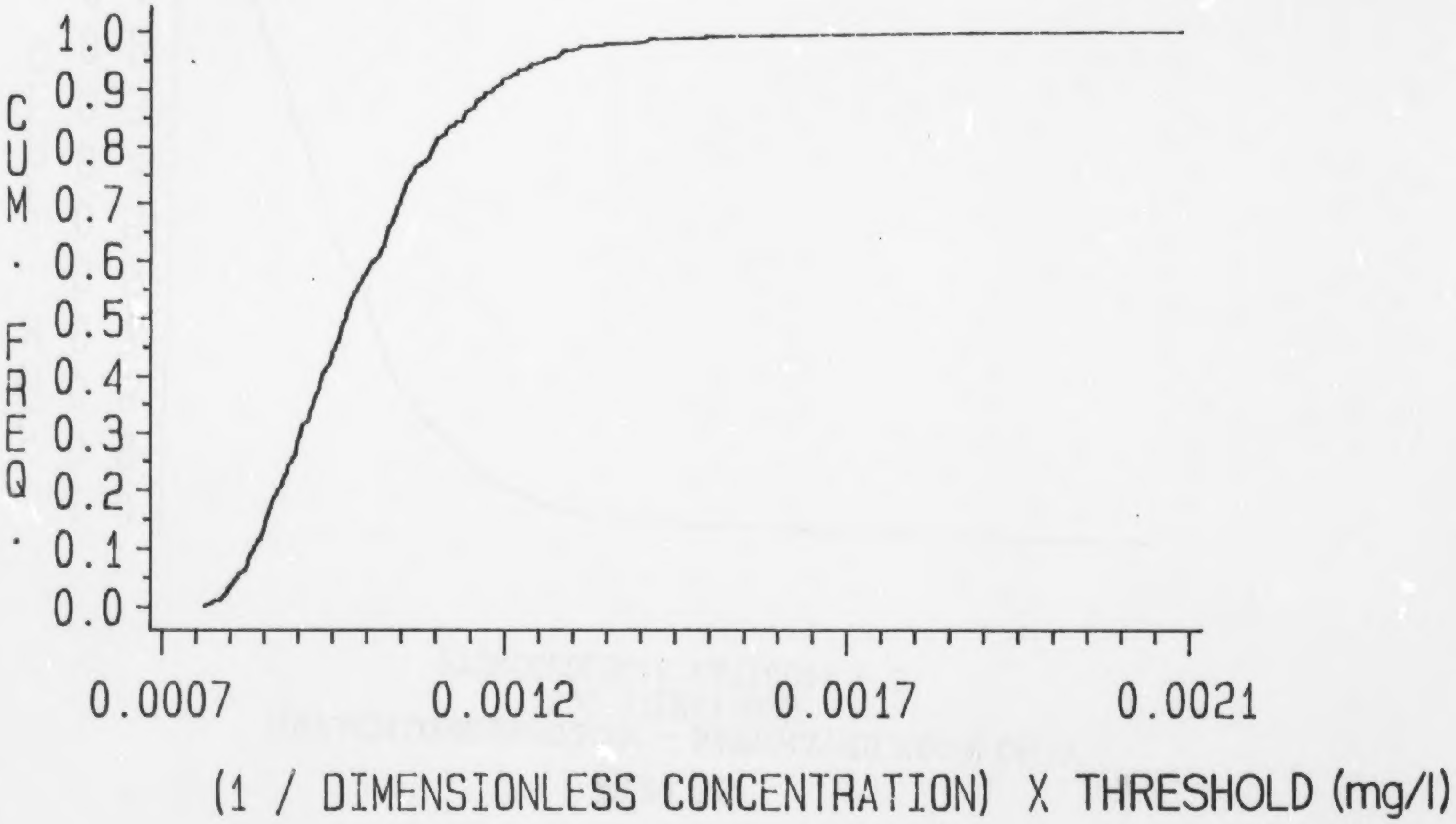
RUN 66

HEXACHLOROBENZENE – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY – 9



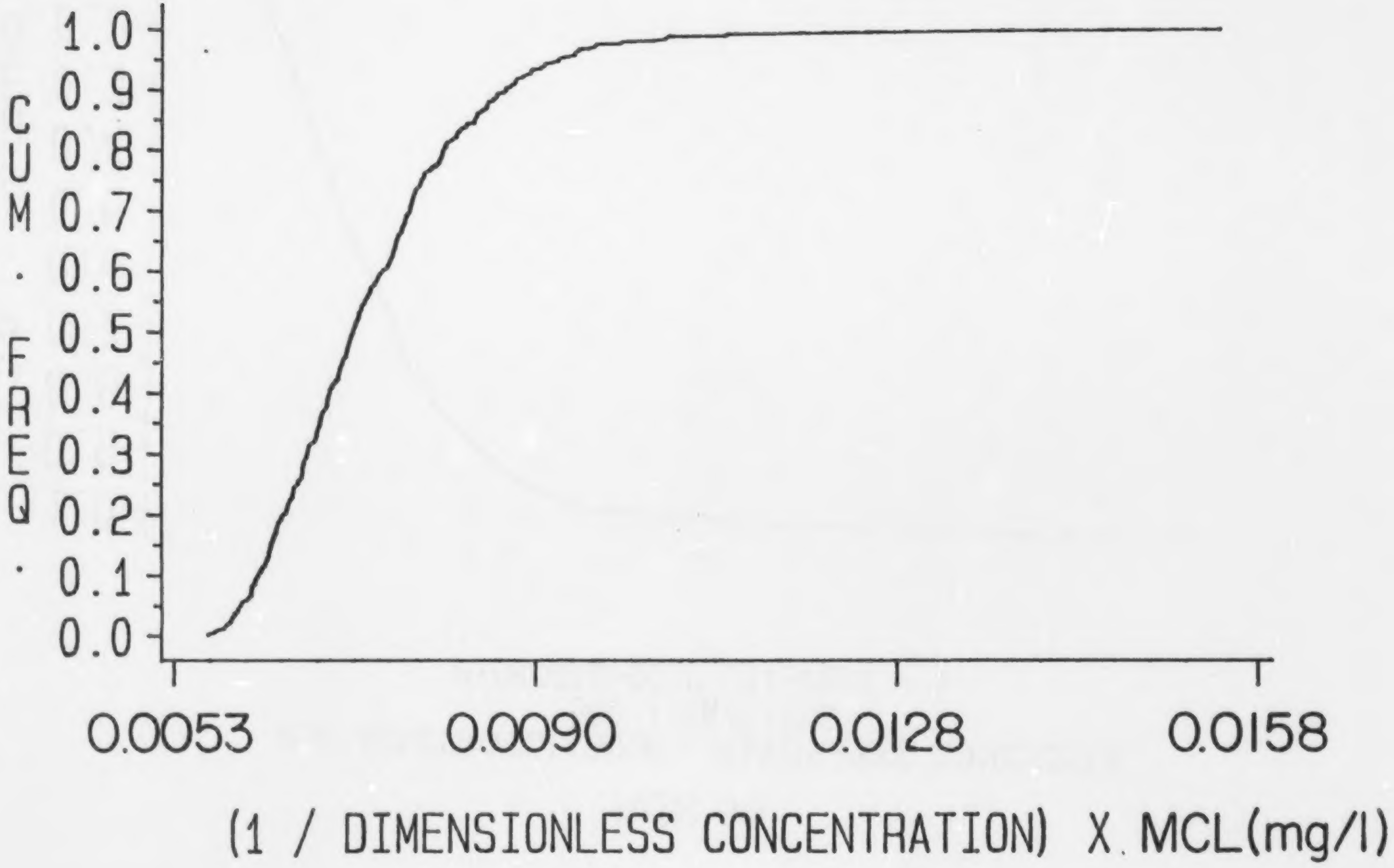
RUN 67

TETRACHLOROETHYLENE – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY – 9



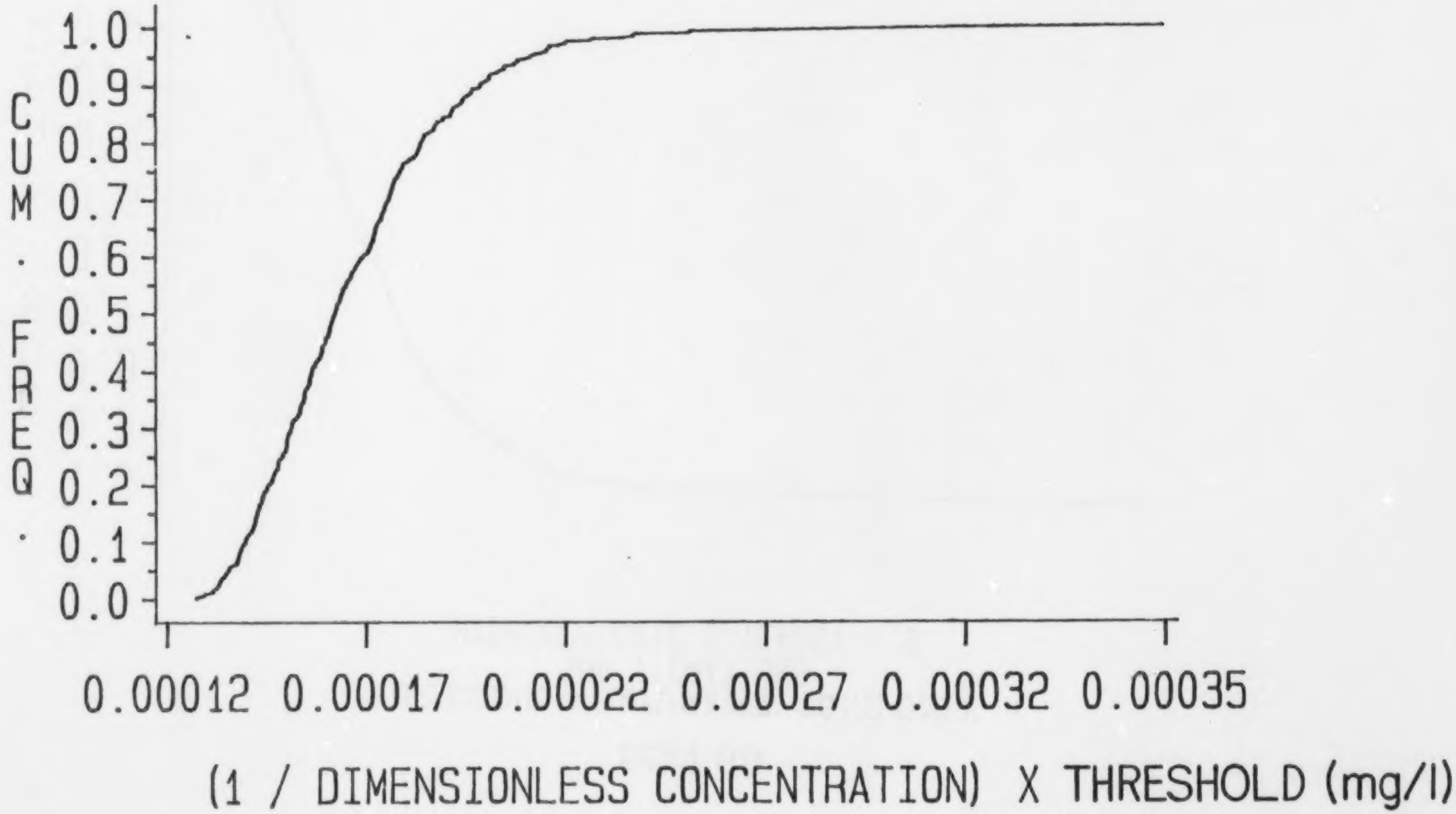
RUN 68

BENZENE – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY - 9



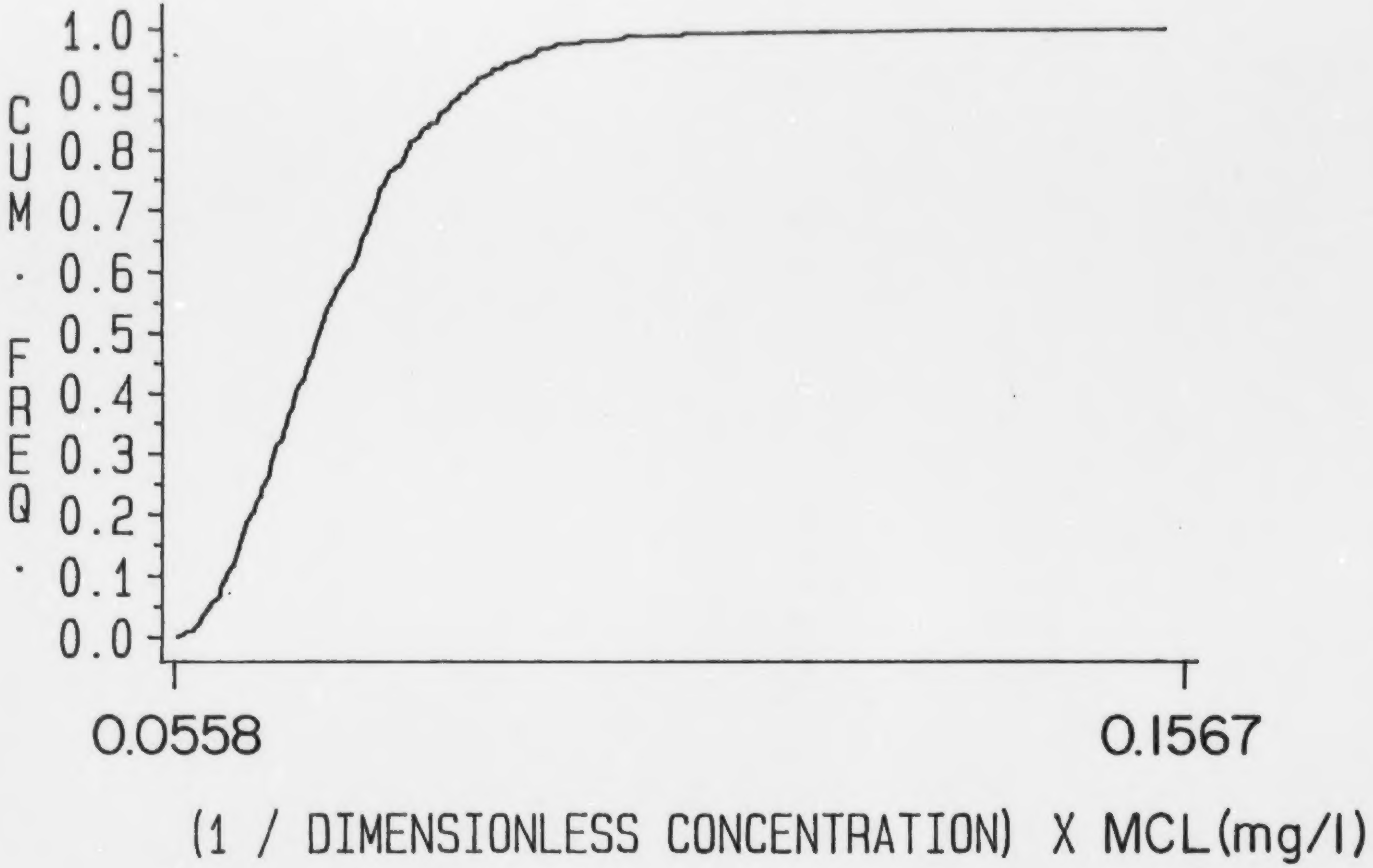
RUN 69

2,4–DINITROTOLUENE – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY – 9



RUN 70

ARSENIC – SATURATED ZONE ONLY
500 ITERATIONS
HYDROGEOLOGIC CATEGORY - 9



APPENDIX 4.7

APPENDIX 4 REFERENCES

APPENDIX 4.7

APPENDIX 4 REFERENCES

1. U.S. Environmental Protection Agency. 1986. Liner Location, Risk and Cost Analysis Model, Phase II Report (Draft). USEPA, Office of Solid Waste.

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APPENDIX 5.1

MODEL LAGOON LEACHATE CONCENTRATIONS

APPENDIX 5.1

MODEL LAGOON LEACHATE CONCENTRATIONS

	Concentration	
	Median	Maximum
Metals, ug/l		
Arsenic	0.2[a]	88
Conventional, mg/l		
NO_2/NO_3-N	0.005[a]	7.3
Volatiles, ug/l		
Benzene	1[a]	11
Chloroform	0.05[a]	86
Tetrachloroethylene	0.01[a]	31
Organics, base-neutral, ug/l		
2,4-Dinitrotoluene	0.02[a]	43
Hexachlorobenzene	1	32

[a] Median calculated using the analytical detection limit value for non-detect values resulted in the detection limit being the median.

Source: See Appendix 3.5

APPENDIX 5.2

NINETIETH PERCENTILE HEALTH RISKS BY SETTING

Appendix 5.2

Distribution of Risks Across Hydrogeologic Settings

Constituent (Leachate Conc.) *		Ninetieth Percentile Health Risks by Hydrogeologic Setting								
		1	2	3	4	5	6	7	8	9
Arsenic	(Median) (Maximum)	6.7E - 07 3.7E - 05	7.4E - 07 4.1E - 05	5.6E - 07 3.1E - 05	4.7E - 07 2.6E - 05	6.2E - 07 3.4E - 05	7.7E - 07 4.2E - 05	7.5E - 07 4.1E - 05	6.7E - 07 3.7E - 05	7.1E - 07 3.9E - 05
Benzene	(Median) (Maximum)	1.2E - 06 1.3E - 05	1.3E - 06 1.4E - 05	9.7E - 07 1.1E - 05	8.1E - 07 9.0E - 06	1.1E - 06 1.2E - 05	1.3E - 06 1.5E - 05	1.3E - 06 1.4E - 05	1.2E - 06 1.3E - 05	1.2E - 06 1.4E - 05
Chloroform	(Median) (Maximum)	8.8E - 08 1.5E - 04	9.4E - 08 1.6E - 04	7.2E - 08 1.2E - 04	6.2E - 08 1.1E - 04	7.9E - 08 1.4E - 04	9.7E - 08 1.7E - 04	9.3E - 08 1.6E - 04	8.9E - 08 1.5E - 04	9.2E - 08 1.6E - 04
2, 4 - Dinitrotoluene	(Median) (Maximum)	1.4E - 07 2.9E - 04	1.5E - 07 3.3E - 04	1.1E - 07 2.4E - 04	9.2E - 08 2.1E - 04	1.3E - 07 2.7E - 04	1.6E - 07 3.4E - 04	1.5E - 07 3.3E - 04	1.4E - 07 3.0E - 04	1.5E - 07 3.1E - 04
Hexachlorobenzene	(Median) (Maximum)	3.8 - 05 1.2E - 03	4.2E - 05 1.3E - 03	3.1E - 05 1.0E - 03	2.6E - 05 8.5E - 04	3.5E - 05 1.1E - 03	4.3E - 05 1.4E - 03	4.2E - 05 1.3E - 03	3.8E - 05 1.2E - 03	4.0E - 05 1.3E - 03
Tetrachloroethylene	(Median) (Maximum)	1.1E - 08 3.5E - 05	1.3E - 08 3.9E - 05	9.5E - 09 2.9E - 05	8.0E - 09 2.5E - 05	1.1E - 08 3.3E - 05	1.3E - 08 4.1E - 05	1.3E - 08 3.9E - 05	1.1E - 08 3.5E - 05	1.2E - 08 3.8E - 05
Nitrate or Nitrite**	(Median) (Maximum)	0.0 0.0	0.0 0.0	0.0 1.1E - 10	0.0 3.5E - 12	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0

* Median refers to Lagoon leachate median concentration value;
Maximum to lagoon leachate maximum concentration.

** Represents a ratio of well concentrarion to the reference dose and is not a risk value.

APPENDIX 5.3

DESCRIPTION OF MAPPING SURVEY

TABLE 5.3-1

TOTAL EXPOSED POPULATION DISTRIBUTION

Distance to Well (m)		Population Exposed	Probability	Cumulative Probability
Lower	Upper			
0	35	10	0.0001	0.0001
35	130	92.5	0.0011	0.0012
130	300	1,781.5	0.0207	0.0219
300	500	4,722	0.0549	0.0768
500	800	61,042.5	0.7093	0.7861
800	1,250	5,520	0.0641	0.8502
1,250	2,000	12,892	0.1498	1.0000

APPENDIX 5.4

CALCULATION OF HEALTH RISKS FROM WELL CONCENTRATIONS

APPENDIX 5.4

CALCULATION OF HEALTH RISKS FROM WELL CONCENTRATIONS

Post-processing software developed for EPACMS takes the dimensionless concentration values produced by EPACMS and transforms these values into risk or hazard values. Carcinogenic and noncarcinogenic risks are calculated separately based upon carcinogenic potency values and noncarcinogenic reference values. Cancer and noncancer health effects are estimated with the following equations:

Carcinogenic Risk:

$R = (C \times F) \times P$, where:

R = Risk (dimensionless)
C = Ground-water contaminant concentration (mg/L)
P = Potency factor (see Table 3-7) (mg/kg/day)-1
F = 0.029 (this is a conversion factor to account for ingestion assumptions).

Noncarcinogenic Hazard:

$H = (C \times F)/RfD$, where:

H = Noncarcinogenic hazard index (dimensionless)
C = Ground-water contaminant concentration (mg/L)
RfD = reference dose (see Table 3-7) (mg/kg/day)-1
F = 0.029 (this is a conversion factor to account for ingestion assumptions).

APPENDIX 5.5

DESCRIPTION OF COMPUTER RUNS

APPENDIX 5.5

DESCRIPTION OF COMPUTER RUNS

One set of EPACMS runs was done to estimate the maximally exposed individual (MEI) risks. This set of runs examined seven pollutants and nine hydrogeologic settings resulting in a total of sixty-three computer runs. Each run consisted of 500 iterations of the Monte Carlo simulator. The model generates a ratio between an estimated well concentration and the leachate concentration (this ratio is called a dimensionless concentration). This ratio is multiplied by the leachate concentration and a ingestion conversion factor. For carcinogenic risk, the result is multiplied by a risk potency factor, P. For noncarcinogenic hazard, the result is divided by a reference dose, RfD.

A post-processing software package was developed to allow these computer runs to be examined in several ways. The computer runs describe the distribution of risks to individuals in a single hydrogeologic setting caused by exposure to a single pollutant. With the post-processing package, analyzing the total risks within each hydrogeologic setting after summing the carcinogenic risks can be done. This allows relatively vulnerable hydrogeologic settings to be identified. The post-processing package also enables aggregation of risks across all environments in order to determine the overall magnitude of the risks posed nationwide by municipal lagoons.

Tables of the input parameters are presented in Appendix 4.4.

APPENDIX 5.6

DATA FROM MODEL OUTPUT

APPENDIX 5.6

DATA FROM MODEL OUTPUT

The attached tables present the outputs of the EPACMS model and the post-processing software. The tables present two sets of outputs corresponding to runs using median well concentrations as input and runs using maximum well concentrations as input. Nine hydrogeologic settings were examined for each concentration input.

Please Note: The data output contains a typographical error. Data for tetrachlorethylene are incorrectly labeled as "tetrachloroethane."

```
   [illegible] AGGREGATE CARCINOGEN RISK TO MEI - AGGREGATED ACROSS ALL HYDROGEOLOGIC CATEGORIES

              AGGREGATE CARCINOGEN RISK = SUM OF RISKS FROM THE FOLLOWING CONSTITUENTS
            CHLOROFORM, BENZENE, HEXACHLOROBENZENE, TETRACHLOROETHANE, 2.4-DINITROTOLUENE

N = 492
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       1.62E-05  1.80E-05  1.94E-05  2.10E-05  2.27E-05  2.42E-05  2.64E-05  2.97E-05  3.43E-05 4.07E-05

   MAXIMUM AGGREGATE CARCINOGEN RISK TO MEI - AGGREGATED ACROSS ALL HYDROGEOLOGIC CATEGORIES

              AGGREGATE CARCINOGEN RISK = SUM OF RISKS FROM THE FOLLOWING CONSTITUENTS
            CHLOROFORM, BENZENE, HEXACHLOROBENZENE, TETRACHLOROETHANE, 2.4-DINITROTOLUENE

N = 492
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       7.03E-04  7.76E-04  8.38E-04  9.12E-04  9.79E-04  1.05E-03  1.14E-03  1.29E-03  1.48E-03 1.77E-03
```

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```
                        MEDIAN RISK OR HAZARD TO MEI IN CATEGORY 1

                     CHLOROFORM: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 8.1 X 10E-2
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       2.6E-08   3.4E-08   4.0E-08   4.7E-08   5.3E-08   6.0E-08   7.1E-08   7.9E-08   8.8E-08   1.0E-07

                     BENZENE: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 5.2 X 10E-2
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       3.5E-07   4.7E-07   5.5E-07   6.3E-07   7.2E-07   8.4E-07   9.5E-07   1.1E-06   1.2E-06   1.3E-06

                     HEXACHLOROBENZENE: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 1.69
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       1.1E-05   1.5E-05   1.8E-05   2.0E-05   2.3E-05   2.7E-05 * 3.1E-05   3.4E-05   3.8E-05   4.3E-05

                     TETRACHLOROETHANE: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 5.1 X  10E-2
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       3.4E-09   4.6E-09   5.4E-09   6.2E-09   7.0E-09   8.2E-09   9.3E-09   1.0E-08   1.1E-08   1.3E-08

                     2,4-DINITROTOLUENE: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 3.1   X 10E-1
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       4.2E-08   5.6E-08   6.6E-08   7.5E-08   8.5E-08   1.0E-07   1.1E-07   1.3E-07   1.4E-07   1.6E-07

                     ARSENIC: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 1.5 X 10E1
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       2.0E-07   2.7E-07   3.2E-07   3.6E-07   4.1E-07   4.8E-07   5.5E-07   6.1E-07   6.7E-07   7.6E-07

                     NITRATE: HAZARD = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) / 1.0 X 10E-1
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       0.0E+00   0.0E+00   0.0E+00   0.0E+00   0.0E+00   0.0E+00   0.0E+00   0.0E+00   0.0E+00   1.3E-08

                     MEDIAN AGGREGATE CARCINOGEN RISK TO MEI - CATEGORY 1
                     AGGREGATE RISK = SUM OF RISKS FROM THE FOLLOWING CONSTITUENTS:
       CHLOROFORM, BENZENE, HEXACHLOROBENZENE, TETRACHLOROETHANE, 2,4-DINITROTOLUENE
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       1.2E-05   1.6E-05   1.9E-05   2.2E-05   2.5E-05   2.9E-05   3.3E-05   3.6E-05   4.0E-05   4.5E-05
```

```
                              MEDIAN RISK OR HAZARD TO MEI IN CATEGORY 2

                   CHLOROFORM: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 8.1 X 10E-2
N =  500
PERCENTILE:    10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:        2.95E-08  3.70E-08  4.55E-08  5.24E-08  6.09E-08  6.99E-08  7.64E-08  8.55E-08  9.36E-08 1.06E-07

                    BENZENE: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 5.2 X 10E-2
N =  500
PERCENTILE:    10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:        4.41E-07  5.24E-07  6.35E-07  7.52E-07  8.62E-07  9.85E-07  1.12E-06  1.21E-06  1.28E-06 1.38E-06

                   HEXACHLOROBENZENE: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 1.69
N =  500
PERCENTILE:    10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:        1.37E-05  1.70E-05  2.06E-05  2.44E-05  2.80E-05  3.20E-05  3.64E-05  3.93E-05  4.18E-05 4.48E-05

                 TETRACHLOROETHANE: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 5.1 X  10E-2
N =  500
PERCENTILE:    10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:        4.13E-09  5.14E-09  6.23E-09  7.37E-09  8.46E-09  9.66E-09  1.10E-08  1.19E-08  1.26E-08 1.35E-08

               2.4-DINITROTOLUENE: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 3.1   X 10E-1
N =  500
PERCENTILE:    10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:        5.02E-08  6.25E-08  7.57E-08  8.96E-08  1.03E-07  1.17E-07  1.33E-07  1.44E-07  1.53E-07 1.64E-07

                     ARSENIC: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 1.5 X 10E1
N =  500
PERCENTILE:    10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:        2.43E-07  3.02E-07  3.66E-07  4.34E-07  4.97E-07  5.66E-07  6.46E-07  6.98E-07  7.41E-07 7.95E-07

                   NITRATE: HAZARD = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) / 1.0 X 10E-1
N =  500
PERCENTILE:    10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:        0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00 0.00E+00

                              MEDIAN AGGREGATE CARCINOGEN RISK TO MEI - CATEGORY 2
                         AGGREGATE RISK = SUM OF RISKS FROM THE FOLLOWING CONSTITUENTS:
                  CHLOROFORM, BENZENE, HEXACHLOROBENZENE, TETRACHLOROETHANE, 2.4-DINITROTOLUENE
N =  500
PERCENTILE:    10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:        1.44E-05  1.80E-05  2.18E-05  2.56E-05  2.96E-05  3.38E-05  3.84E-05  4.15E-05  4.40E-05 4.72E-05
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                                        MEDIAN RISK OR HAZARD TO MEI IN CATEGORY 3

                              CHLOROFORM: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 8.1 X 10E-2
N =  500
PERCENTILE:    10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:      2.[illegible]3E-08  2.57E-08  2.91E-08  3.16E-08  3.47E-08  3.88E-08  4.41E-08  5.27E-08  7.21E-08 9.76E-08

                               BENZENE: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 5.2 X 10E-2
N =  500
PERCENTILE:    10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:      2.96E-07  3.51E-07  3.88E-07  4.19E-07  4.58E-07  5.07E-07  5.88E-07  7.03E-07  9.66E-07 1.26E-06

                         HEXACHLOROBENZENE: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 1.69
N =  500
PERCENTILE:    10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:      9.09E-06  1.14E-05  1.26E-05  1.36E-05  1.49E-05  1.65E-05  1.91E-05  2.29E-05  3.14E-05 4.10E-05

                    TETRACHLOROETHANE: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 5.1 X  10E-2
N =  500
PERCENTILE:    10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:      2.93E-09  3.45E-09  3.80E-09  4.11E-09  4.49E-09  4.97E-09  5.77E-09  6.90E-09  9.47E-09 1.24E-08

                    2,4-DINITROTOLUENE: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 3.1   X 10E-1
N =  500
PERCENTILE:    10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:      3.56E-08  4.19E-08  4.62E-08  5.00E-08  5.46E-08  6.04E-08  7.02E-08  8.39E-08  1.15E-07 1.50E-07

                              ARSENIC: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 1.5 X 10E1
N =  500
PERCENTILE:    10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:      1.72E-07  2.03E-07  2.24E-07  2.42E-07  2.64E-07  2.92E-07  3.39E-07  4.06E-07  5.57E-07 7.28E-07

                              NITRATE: HAZARD = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) / 1.0 X 10E-1
N =  500
PERCENTILE:    10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:      0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00 5.50E-08

                                    MEDIAN AGGREGATE CARCINOGEN RISK TO MEI - CATEGORY 3
                                 AGGREGATE RISK = SUM OF RISKS FROM THE FOLLOWING CONSTITUENTS:
                          CHLOROFORM, BENZENE, HEXACHLOROBENZENE, TETRACHLOROETHANE, 2,4-DINITROTOLUENE
N =  500
PERCENTILE:    10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:      1.0[illegible]E-05  1.20E-05  1.33E-05  1.44E-05  1.57E-05  1.74E-05  2.02E-05  2.41E-05  3.31E-05 4.32E-05
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                                        MEDIAN RISK OR HAZARD TO MEI IN CATEGORY 4

                           CHLOROFORM: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 8.1 X 10E-2
N =  500
PERCENTILE:    10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:        1.70E-08  1.99E-08  2.20E-08  2.45E-08  2.70E-08  3.14E-08  3.63E-08  4.39E-08  6.16E-08 9.03E-08

                            BENZENE: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 5.2 X 10E-2
N =  500
PERCENTILE:    10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:        2.24E-07  2.67E-07  2.91E-07  3.28E-07  3.59E-07  4.16E-07  4.88E-07  5.85E-07  8.15E-07 1.19E-06

                          HEXACHLOROBENZENE; RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 1.69
N =  500
PERCENTILE:    10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:        7.29E-06  8.66E-06  9.45E-06  1.07E-05  1.17E-05  1.35E-05  1.59E-05  1.90E-05  2.65E-05 3.87E-05

                      TETRACHLOROETHANE: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 5.1 X  10E-2
N =  500
PERCENTILE:    10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:        2.20E-09  2.61E-09  2.85E-09  3.21E-09  3.52E-09  4.08E-09  4.78E-09  5.73E-09  8.00E-09 1.17E-08

                     2,4-DINITROTOLUENE: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 3.1   X 10E-1
N =  500
PERCENTILE:    10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:        2.67E-08  3.18E-08  3.47E-08  3.91E-08  4.28E-08  4.96E-08  5.82E-08  6.97E-08  9.72E-08 1.42E-07

                            ARSENIC: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 1.5 X 10E1
N =  500
PERCENTILE:    10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:        1.29E-07  1.54E-07  1.68E-07  1.89E-07  2.07E-07  2.40E-07  2.81E-07  3.37E-07  4.70E-07 6.87E-07

                           NITRATE: HAZARD = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) / 1.0 X 10E-1
N =  500
PERCENTILE:    10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:        0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00 1.46E-07

                                  MEDIAN AGGREGATE CARCINOGEN RISK TO MEI - CATEGORY 4
                             AGGREGATE RISK = SUM OF RISKS FROM THE FOLLOWING CONSTITUENTS:
                      CHLOROFORM, BENZENE, HEXACHLOROBENZENE, TETRACHLOROETHANE, 2,4-DINITROTOLUENE
N =  500
PERCENTILE:    10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:        7.69E-06  9.14E-06  9.97E-06  1.12E-05  1.23E-05  1.43E-05  1.67E-05  2.00E-05  2.79E-05 4.08E-05
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                              MEDIAN RISK OF HAZARD TO MEI IN CATEGORY 5

                    CHLOROFORM: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 8.1 X 10E-2
N =  500
PERCENTILE:   10TH       20TH       30TH       40TH       50TH       60TH       70TH       80TH       90TH      100TH
RISK:       [illegible] 3.32E-08  3.70E-08  4.14E-08  4.62E-08  5.07E-08  5.79E-08  6.73E-08  7.94E-08 9.51E-08

                    BENZENE: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 5.2 X 10E-2
N =  500
PERCENTILE:   10TH       20TH       30TH       40TH       50TH       60TH       70TH       80TH       90TH      100TH
RISK:       4.01E-07  4.48E-07  5.00E-07  5.60E-07  6.25E-07  6.93E-07  7.75E-07  9.20E-07  1.08E-06 1.23E-06

                    HEXACHLOROBENZENE: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 1.69
N =  500
PERCENTILE:   10TH       20TH       30TH       40TH       50TH       60TH       70TH       80TH       90TH      100TH
RISK:       1.30E-05  1.46E-05  1.62E-05  1.82E-05  2.03E-05  2.25E-05  2.52E-05  2.99E-05  3.50E-05 4.00E-05

                 TETRACHLOROETHANE: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 5.1 X  10E-2
N =  500
PERCENTILE:   10TH       20TH       30TH       40TH       50TH       60TH       70TH       80TH       90TH      100TH
RISK:       3.93E-09  4.40E-09  4.90E-09  5.49E-09  6.13E-09  6.80E-09  7.60E-09  9.02E-09  1.06E-08 1.21E-08

                2.4-DINITROTOLUENE: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 3.1   X 10E-1
N =  500
PERCENTILE:   10TH       20TH       30TH       40TH       50TH       60TH       70TH       80TH       90TH      100TH
RISK:       4.78E-08  5.34E-08  5.96E-08  6.66E-08  7.46E-08  8.27E-08  9.24E-08  1.10E-07  1.28E-07 1.47E-07

                     ARSENIC: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 1.5 X 10E1
N =  500
PERCENTILE:   10TH       20TH       30TH       40TH       50TH       60TH       70TH       80TH       90TH      100TH
RISK:       2.31E-07  2.59E-07  2.88E-07  3.23E-07  3.61E-07  4.00E-07  4.47E-07  5.31E-07  6.21E-07 7.10E-07

                    NITRATE: HAZARD = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) / 1.0 X 10E-1
N =  500
PERCENTILE:   10TH       20TH       30TH       40TH       50TH       60TH       70TH       80TH       90TH      100TH
RISK:       0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00 1.32E-11

                          MEDIAN AGGREGATE CARCINOGEN RISK TO MEI - CATEGORY 5
                        AGGREGATE RISK = SUM OF RISKS FROM THE FOLLOWING CONSTITUENTS:
                 CHLOROFORM, BENZENE, HEXACHLOROBENZENE, TETRACHLOROETHANE, 2.4-DINITROTOLUENE
N =  500
PERCENTILE:   10TH       20TH       30TH       40TH       50TH       60TH       70TH       80TH       90TH      100TH
RISK:       1.37E-05  1.54E-05  1.71E-05  1.92E-05  2.14E-05  2.38E-05  2.66E-05  3.15E-05  3.69E-05 4.22E-05
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                         MEDIAN RISK OR HAZARD TO MEI IN CATEGORY 6

              CHLOROFORM: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 8.1 X 10E-2
N =  493
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:      2.53E-08  3.71E-08  4.81E-08  5.90E-08  6.84E-08  7.60E-08  8.21E-08  8.94E-08  9.66E-08 1.04E-07

               BENZENE: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 5.2 X 10E-2
N =  493
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:      7.05E-07  9.59E-07  1.08E-06  1.14E-06  1.19E-06  1.24E-06  1.28E-06  1.30E-06  1.34E-06 1.41E-06

              HEXACHLOROBENZENE: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 1.69
N =  493
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:      2.29E-05  3.12E-05  3.52E-05  3.72E-05  3.88E-05  4.02E-05  4.15E-05  4.23E-05  4.35E-05 4.59E-05

          TETRACHLOROETHANE: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 5.1 X  10E-2
N =  493
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:      6.91E-09  9.40E-09  1.06E-08  1.12E-08  1.17E-08  1.21E-08  1.25E-08  1.28E-08  1.31E-08 1.38E-08

          2.4-DINITROTOLUENE: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 3.1   X 10E-1
N =  493
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:      8.40E-08  1.14E-07  1.29E-07  1.36E-07  1.42E-07  1.48E-07  1.52E-07  1.55E-07  1.60E-07 1.68E-07

               ARSENIC: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 1.5 X 10E1
N =  493
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:      4.07E-07  5.53E-07  6.25E-07  6.60E-07  6.89E-07  7.14E-07  7.37E-07  7.52E-07  7.73E-07 8.14E-07

              NITRATE: HAZARD = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) / 1.0 X 10E-1
N =  484
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:      0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00 0.00E+00

                          MEDIAN AGGREGATE CARCINOGEN RISK TO MEI - CATEGORY 6
                     AGGREGATE RISK = SUM OF RISKS FROM THE FOLLOWING CONSTITUENTS:
           CHLOROFORM, BENZENE, HEXACHLOROBENZENE, TETRACHLOROETHANE, 2.4-DINITROTOLUENE
N =  493
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:      2.41E-05  3.28E-05  3.71E-05  3.92E-05  4.09E-05  4.24E-05  4.38E-05  4.46E-05  4.59E-05 4.84E-05
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                              MEDIAN RISK OR HAZARD TO MEI IN CATEGORY 7

                        CHLOROFORM: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 8.1 X 10E-2
N =  497
PERCENTILE:   10TH     20TH     30TH     40TH     50TH     60TH     70TH     80TH     90TH     100TH
RISK:       2.39E-08 3.77E-08 4.93E-08 6.22E-08 6.76E-08 7.34E-08 8.01E-08 8.55E-08 9.32E-08 1.03E-07

                         BENZENE: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 5.2 X 10E-2
N =  497
PERCENTILE:   10TH     20TH     30TH     40TH     50TH     60TH     70TH     80TH     90TH     100TH
RISK:       8.65E-07 9.72E-07 1.03E-06 1.08E-06 1.13E-06 1.17E-06 1.20E-06 1.25E-06 1.30E-06 1.37E-06

                        HEXACHLOROBENZENE: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 1.69
N =  497
PERCENTILE:   10TH     20TH     30TH     40TH     50TH     60TH     70TH     80TH     90TH     100TH
RISK:       2.81E-05 3.16E-05 3.35E-05 3.51E-05 3.66E-05 3.80E-05 3.91E-05 4.05E-05 4.22E-05 4.46E-05

                    TETRACHLOROETHANE: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 5.1 X  10E-2
N =  497
PERCENTILE:   10TH     20TH     30TH     40TH     50TH     60TH     70TH     80TH     90TH     100TH
RISK:       8.48E-09 9.53E-09 1.01E-08 1.06E-08 1.11E-08 1.15E-08 1.18E-08 1.22E-08 1.27E-08 1.35E-08

                  2.4-DINITROTOLUENE: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 3.1   X 10E-1
N =  497
PERCENTILE:   10TH     20TH     30TH     40TH     50TH     60TH     70TH     80TH     90TH     100TH
RISK:       1.03E-07 1.16E-07 1.23E-07 1.29E-07 1.34E-07 1.39E-07 1.44E-07 1.49E-07 1.55E-07 1.64E-07

                         ARSENIC: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 1.5 X 10E1
N =  497
PERCENTILE:   10TH     20TH     30TH     40TH     50TH     60TH     70TH     80TH     90TH     100TH
RISK:       4.99E-07 5.61E-07 5.95E-07 6.24E-07 6.50E-07 6.74E-07 6.95E-07 7.20E-07 7.49E-07 7.92E-07

                        NITRATE: HAZARD = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) / 1.0 X 10E-1
N =  493
PERCENTILE:   10TH     20TH     30TH     40TH     50TH     60TH     70TH     80TH     90TH     100TH
RISK:       0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00

                            MEDIAN AGGREGATE CARCINOGEN RISK TO MEI - CATEGORY 7
                          AGGREGATE RISK = SUM OF RISKS FROM THE FOLLOWING CONSTITUENTS:
                  CHLOROFORM, BENZENE, HEXACHLOROBENZENE, TETRACHLOROETHANE, 2.4-DINITROTOLUENE
N =  497
PERCENTILE:   10TH     20TH     30TH     40TH     50TH     60TH     70TH     80TH     90TH     100TH
RISK:      [illegible] 3.33E-05 3.53E-05 3.70E-05 3.86E-05 4.00E-05 4.13E-05 4.27E-05 4.44E-05 4.71E-05
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                              MEDIAN RISK OR HAZARD TO MEI IN CATEGORY 8

                     CHLOROFORM: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 8.1 X 10E-2
N =  500
PERCENTILE:    10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:        2.81E-08  3.85E-08  4.73E-08  5.52E-08  6.39E-08  7.07E-08  7.89E-08  8.48E-08  8.91E-08 9.58E-08

                       BENZENE: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 5.2 X 10E-2
N =  500
PERCENTILE:    10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:        3.76E-07  5.20E-07  6.23E-07  7.45E-07  8.47E-07  9.57E-07  1.04E-06  1.11E-06  1.17E-06 1.25E-06

                     HEXACHLOROBENZENE: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 1.69
N =  500
PERCENTILE:    10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:        1.22E-05  1.69E-05  2.03E-05  2.42E-05  2.75E-05  3.11E-05  3.39E-05  3.61E-05  3.79E-05 4.06E-05

                   TETRACHLOROETHANE: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 5.1 X  10E-2
N =  500
PERCENTILE:    10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:        3.68E-09  5.10E-09  6.11E-09  7.30E-09  8.31E-09  9.39E-09  1.02E-08  1.09E-08  1.14E-08 1.23E-08

                 2,4-DINITROTOLUENE: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 3.1   X 10E-1
N =  500
PERCENTILE:    10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:        4.46E-08  6.20E-08  7.43E-08  8.88E-08  1.01E-07  1.14E-07  1.24E-07  1.32E-07  1.39E-07 1.49E-07

                        ARSENIC: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 1.5 X 10E1
N =  500
PERCENTILE:    10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:        2.17E-07  3.00E-07  3.60E-07  4.30E-07  4.89E-07  5.52E-07  6.01E-07  6.40E-07  6.73E-07 7.21E-07

                      NITRATE: HAZARD = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) / 1.0 X 10E-1
N =  500
PERCENTILE:    10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:        0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00 3.59E-08

                              MEDIAN AGGREGATE CARCINOGEN RISK TO MEI - CATEGORY 8
                          AGGREGATE RISK = SUM OF RISKS FROM THE FOLLOWING CONSTITUENTS:
                    CHLOROFORM, BENZENE, HEXACHLOROBENZENE. TETRACHLOROETHANE. 2,4-DINITROTOLUENE
N =  500
PERCENTILE:    10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:        1.29E-05  1.78E-05  2.14E-05  2.55E-05  2.90E-05  3.28E-05  3.57E-05  3.80E-05  4.00E-05 4.29E-05
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                    MEDIAN RISK OR HAZARD TO MEI IN CATEGORY 9

              CHLOROFORM: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 8.1 X 10E-2
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       4.63E-08  5.73E-08  6.52E-08  7.04E-08  7.45E-06  7.87E-08  8.23E-08  8.67E-08  9.23E-08 1.02E-07

              BENZENE: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 5.2 X 10E-2
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       8.87E-07  9.55E-07  9.96E-07  1.03E-06  1.07E-06  1.11E-06  1.15E-06  1.19E-06  1.24E-06 1.34E-06

              HEXACHLOROBENZENE: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 1.69
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       2.86E-05  3.10E-05  3.24E-05  3.36E-05  3.49E-05  3.61E-05  3.73E-05  3.87E-05  4.02E-05 4.37E-05

              TETRACHLOROETHANE: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 5.1 X  10E-2
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       8.70E-09  9.36E-09  9.77E-09  1.01E-08  1.05E-08  1.09E-08  1.13E-08  1.17E-08  1.21E-08 1.32E-08

              2.4 DINITROTOLUENE: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 3.1   X 10E-1
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       1.06E-07  1.14E-07  1.19E-07  1.23E-07  1.28E-07  1.32E-07  1.37E-07  1.42E-07  1.47E-07 1.60E-07

              ARSENIC: RISK = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) X 1.5 X 10E1
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       5.12E-07  5.51E-07  5.75E-07  5.96E-07  6.19E-07  6.40E-07  6.62E-07  6.86E-07  7.13E-07 7.76E-07

              NITRATE: HAZARD = (MEDIAN WELL CONCENTRATION IN MG/L X 0.029) / 1.0 X 10E-1
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00 2.87E-11

                    MEDIAN AGGREGATE CARCINOGEN RISK TO MEI - CATEGORY 9
                  AGGREGATE RISK = SUM OF RISKS FROM THE FOLLOWING CONSTITUENTS:
              CHLOROFORM, BENZENE, HEXACHLOROBENZENE, TETRACHLOROETHANE, 2.4-DINITROTOLUENE
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       3.04E-05  3.27E-05  3.41E-05  3.54E-05  3.66E-05  3.80E-05  3.93E-05  4.06E-05  4.24E-05 4.61E-05
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                         MAXIMUM RISK OR HAZARD TO MEI - CATEGORY 1

                  CHLOROFORM: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 8.1 X 10E-2
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       4.5E-05   5.9E-05   6.9E-05   8.0E-05   9.2E-05   1.0E-04   1.2E-04   1.4E-04   1.5E-04  1.8E-04

                   BENZENE: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 5.2 X 10E-2
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       3.8E-06   5.2E-06   6.1E-06   6.9E-06   7.9E-06   9.2E-06   1.0E-05   1.2E-05   1.3E-05  1.5E-05

                  HEXACHLOROBENZENE: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 1.69
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       3.6E-04   4.9E-04   5.8E-04   6.5E-04   7.5E-04   8.7E-04   9.9E-04   1.1E-03   1.2E-03  1.4E-03

               TETRACHLOROETHANE: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 5.1 X 10E-2
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       1.1E-05   1.4E-05   1.7E-05   1.9E-05   2.2E-05   2.6E-05   2.9E-05   3.2E-05   3.5E-05  4.0E-05

              2,4-DINITROTOLUENE: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 3.1  X 10E-1
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       6.9E-05   1.2E-04   1.4E-04   1.6E-04   1.8E-04   2.1E-04   2.4E-04   2.7E-04   2.9E-04  3.3E-04

                   ARSENIC: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 1.5 X 10E1
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       1.1E-05   1.5E-05   1.8E-05   2.0E-05   2.3E-05   2.7E-05   3.0E-05   3.3E-05   3.7E-05  4.2E-05

                  NITRATE: HAZARD = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) / 1.0 X 10E-1
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       0.0E+00   0.0E+00   0.0E+00   0.0E+00   0.0E+00   0.0E+00   0.0E+00   0.0E+00   0.0E+00  1.9E-05

                           MAXIMUM AGGREGATE CARCINOGEN RISK TO MEI - CATEGORY 1
                        AGGREGATE RISK = SUM OF RISKS FROM THE FOLLOWING CONSTITUENTS:
                 CHLOROFORM, BENZENE, HEXACHLOROBENZENE, TETRACHLOROETHANE, 2,4-DINITROTOLUENE
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       5.[illegible]E-04   7.0E-04   8.3E-04   9.4E-04   1.1E-03   1.2E-03   1.4E-03   1.6E-03   1.7E-03  2.0E-03
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                          MAXIMUM RISK OR HAZARD TO MEI IN CATEGORY 2

                    CHLOROFORM: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 8.1 X 10E-2
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       5.07E-05  6.50E-05  7.82E-05  9.01E-05  1.05E-04  1.20E-04  1.31E-04  1.47E-04  1.61E-04 1.82E-04

                     BENZENE: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 5.2 X 10E-2
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       4.63E-06  5.77E-06  6.98E-06  8.27E-06  9.40E-06  1.08E-05  1.23E-05  1.33E-05  1.41E-05 1.52E-05

                   HEXACHLOROBENZENE: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 1.69
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       4.38E-04  5.45E-04  6.60E-04  7.82E-04  8.97E-04  1.02E-03  1.16E-03  1.26E-03  1.34E-03 1.43E-03

                  TETRACHLOROETHANE: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 5.1 X 10E-2
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       1.26E-05  1.59E-05  1.93E-05  2.29E-05  2.62E-05  3.00E-05  3.40E-05  3.68E-05  3.91E-05 4.19E-05

                2,4-DINITROTOLUENE: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 3.1  X 10E-1
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       1.07E-04  1.33E-04  1.61E-04  1.91E-04  2.19E-04  2.50E-04  2.84E-04  3.07E-04  3.26E-04 3.50E-04

                     ARSENIC: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 1.5 X 10E1
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       1.34E-05  1.66E-05  2.01E-05  2.39E-05  2.74E-05  3.13E-05  3.55E-05  3.84E-05  4.06E-05 4.37E-05

                     NITRATE: HAZARD = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) / 1.0 X 10E-1
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00 1.25E-09

                        MAXIMUM AGGREGATE CARCINOGEN RISK TO MEI - CATEGORY 2
                     AGGREGATE RISK = SUM OF RISKS FROM THE FOLLOWING CONSTITUENTS:
               CHLOROFORM, BENZENE, HEXACHLOROBENZENE, TETRACHLOROETHANE, 2,4-DINITROTOLUENE
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       [illegible]  7.8[illegible]E-04  9.5[illegible]E-04  1.1[illegible]E-03  1.29E-03  1.47E-03  1.67E-03  1.80E-03  1.9[illegible]E-03 2.07E-03
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                MAXIMUM RISK OR HAZARD TO MEI IN CATEGORY 3

          CHLOROFORM: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 8.1 X 10E-2
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      [illegible]     100TH
RISK:       3.84E-05  4.43E-05  5.0[illegible]E-05  5.43E-05  5.97E-05  6.67E-05  7.58E-05  9.07E-05  [illegible] 1.68E-04

           BENZENE: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 5.2 X 10E-2
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      [illegible]     100TH
RISK:       3.26E-06  3.87E-06  4.26E-06  4.6[illegible]E-06  5.04E-06  5.57E-06  6.47E-06  7.74E-06  [illegible] 1.33E-05

         HEXACHLOROBENZENE: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 1.69
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      [illegible]     100TH
RISK:       3.10E-04  3.65E-04  4.03E-04  4.36E-04  4.77E-04  5.27E-04  6.12E-04  7.32E-04  [illegible] 1.31E-03

        TETRACHLOROETHANE: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X [illegible] X 10E-[illegible]
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      [illegible]     100TH
RISK:       9.07E-06  1.07E-05  1.18E-05  1.27E-05  1.39E-05  1.54E-05  1.75E-05  2.14E-05  [illegible] 3.03E-05

       2,4-DINITROTOLUENE: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 3.1  X 10E-1
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      [illegible]     100TH
RISK:       7.57E-05  8.93E-05  9.85E-05  1.06E-04  1.16E-04  1.29E-04  1.49E-04  1.79E-04  [illegible] 3.20E-04

           ARSENIC: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 1.5 X 10E1
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      [illegible]     100TH
RISK:       9.46E-06  1.12E-05  1.23E-05  1.33E-05  1.45E-05  1.6[illegible]E-05  1.87E-05  2.23E-05  [illegible] 4.00E-05

           NITRATE: HAZARD = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) [illegible] 1.0 X 10E 1
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      [illegible]     100TH
RISK:       0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  [illegible] [illegible]

               MAXIMUM AGGREGATE CARCINOGEN RISK TO MEI IN CATEGORY [illegible]
            AGGREGATE RISK = SUM OF RISKS FROM THE FOLLOWING CONSTITUENTS:
        CHLOROFORM, BENZENE, HEXACHLOROBENZENE, TETRACHLOROETHANE, [illegible]

N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      [illegible]     [illegible]     100TH
RISK:       4.47E-04  5.26E-04  5.82E-04  6.17E-04  6.87E-04  7.62E-04  8.82E-04  [illegible]  [illegible] [illegible]
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                         [illegible]

          [illegible]: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 6.1 X 10E-2
   500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       2.96E-05  3.42E-05  3.78E-05  4.21E-05  4.65E-05  5.40E-05  6.24E-05  7.54E-05  1.06E-04  1.55E-04

              BENZENE: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 5.2 X 10E-2
   500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       2.47E-06  [illegible] 3.20E-06 3.61E-06 3.93E-06  4.57E-06  5.37E-06  6.42E-06  8.97E-06  1.31E-05

           HEXACHLOROBENZENE: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 1.69
   500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       2.33E-04  2.77E-04  3.02E-04  3.41E-04  3.73E-04  4.32E-04  5.07E-04  6.06E-04  8.48E-04  1.24E-03

        TETRACHLOROETHANE: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 5.1 X 10E-2
   500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       6.83E-06  8.10E-06  8.84E-06  9.97E-06  1.04E-05  1.26E-05  1.48E-05  1.78E-05  2.48E-05  3.62E-05

       2,4-DINITROTOLUENE: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 3.1  X 10E-1
   500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       5.70E-05  6.77E-05  7.39E-05  8.38E-05  9.12E-05  1.06E-04  1.24E-04  1.48E-04  2.07E-04  3.02E-04

              ARSENIC: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 1.5 X 10:1
   500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       7.12E-06  8.46E-06  9.23E-06  1.04E-05  1.14E-05  1.32E-05  1.55E-05  1.86E-05  2.59E-05  3.78E-05

            NITRATE: HAZARD = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) / 1.0 X 10E 1
   500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  3.50E-12  2.13E-04

                  MAXIMUM AGGREGATE CARCINOGEN RISK TO M-1 - CATEGORY 4
               AGGREGATE RISK = SUM OF RISKS FROM THE FOLLOWING CONSTITUENTS:
      CHLOROFORM, BENZENE, HEXACHLOROBENZENE, TETRACHLOROETHANE, 2,4-DINITROTOLUENE
   500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       3.36E-04  [illegible] 4.36E-04 4.9?E-04 [illegible] 6.24E-04 [illegible] [illegible] [illegible] 1.7?E-03
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                                    MAXIMUM RISK OR HAZARD TO MEI IN CATEGORY 5

                         CHLOROFORM: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X [illegible] X 10E-2
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH      100TH
RISK:       4.93E-05  5.71E-05  6.36E-05  7.12E-05  7.95E-05  8.71E-05  9.97E-05  1.16E-04  1.37E-04 1.64E-04

                          BENZENE: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 5.2 X 10E-2
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH      100TH
RISK:       4.41E-06  4.93E-06  5.50E-06  6.16E-06  6.88E-06  7.63E-06  8.52E-06  1.01E-05  1.18E-05 1.35E-05

                       HEXACHLOROBENZENE: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 1.69
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH      100TH
RISK:       4.17E-04  4.66E-04  5.20E-04  5.83E-04  6.50E-04  7.21E-04  8.06E-04  9.57E-04  1.12E-03 1.28E-03

                    TETRACHLOROETHANE: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 5.1 X 10E-2
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH      100TH
RISK:       1.22E-05  1.36E-05  1.52E-05  1.70E-05  1.90E-05  2.11E-05  2.36E-05  2.80E-05  3.27E-05 3.74E-05

                    2,4-DINITROTOLUENE: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X [illegible] X 10E-1
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH      100TH
RISK:       1.02E-04  1.14E-04  1.27E-04  1.42E-04  1.59E-04  1.76E-04  1.97E-04  2.34E-04  2.74E-04 3.13E-04

                          ARSENIC: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 1.5 X 10E1
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH      100TH
RISK:       1.27E-05  1.42E-05  1.59E-05  1.76E-05  1.98E-05  2.20E-05  2.46E-05  2.92E-05  3.42E-05 3.91E-05

                        NITRATE: HAZARD = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) / 1.0 X 10E 1
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH      100TH
RISK:       0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00 1.94E-06

                                 MAXIMUM AGGREGATE CARCINOGEN RISK TO MEI IN CATEGORY 5
                            AGGREGATE RISK = SUM OF RISKS FROM THE FOLLOWING CONSTITUENTS:
                     CHLOROFORM, BENZENE, HEXACHLOROBENZENE, TETRACHLOROETHANE, 2,4-DINITROTOLUENE
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH      100TH
RISK:       6.00E-04  6.66E-04  7.4[illegible]E-04  8.30E-04  9.35E-04  1.03E-03  1.15E-03  [illegible]  [illegible] 1.85E-03
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                              MAXIMUM RISK OR HAZARD TO MEI IN CATEGORY C

                         CHLOROFORM: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 8.1 X 10E-2
N =  493
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH      100TH
RISK:       4.35E-05  6.37E-05  8.27E-05  1.01E-04  1.16E-04  1.31E-04  1.41E-04  1.54E-04  1.66E-04 1.78E-04

                           BENZENE: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 2.9 X 10E-2
N =  493
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH      100TH
RISK:       7.75E-06  1.05E-05  1.19E-05  1.26E-05  1.31E-05  1.36E-05  1.40E-05  1.43E-05  1.47E-05 1.55E-05

                      HEXACHLOROBENZENE: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 1.69
N =  493
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH      100TH
RISK:       7.33E-04  9.97E-04  1.13E-03  1.19E-03  1.24E-03  1.29E-03  1.33E-03  1.35E-03  1.39E-03 1.47E-03

                 TETRACHLOROETHANE: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 5.1 X 10E-2
N =  493
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH      100TH
RISK:       2.14E-05  2.92E-05  3.29E-05  3.48E-05  3.63E-05  3.76E-05  3.88E-05  3.96E-05  4.07E-05 4.29E-05

                2,4-DINITROTOLUENE: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 5.1  X 10E-1
N =  493
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH      100TH
RISK:       1.79E-04  2.43E-04  2.75E-04  2.90E-04  3.03E-04  3.14E-04  3.24E-04  3.31E-04  3.40E-04 3.58E-04

                          ARSENIC: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 1.5 X 10E1
N =  493
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH      100TH
RISK:       2.24E-05  3.04E-05  3.44E-05  3.63E-05  3.79E-05  3.93E-05  4.05E-05  4.13E-05  4.25E-05 4.48E-05

                        NITRATE: HAZARD = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) / 1.0 X 10E-1
N =  484
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH      100TH
RISK:       0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00 0.00E+00

                              MAXIMUM AGGREGATE CARCINOGEN RISK TO MEI - CATEGORY C
                            AGGREGATE RISK = SUM OF RISKS FROM THE FOLLOWING CONSTITUENTS:
                     CHLOROFORM, BENZENE, HEXACHLOROBENZENE, TETRACHLOROETHANE, 2,4-DINITROTOLUENE
N =  493
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH      100TH
RISK:       1.04E-03  1.40E-03  1.55E-03  1.66E-03  1.74E-03  1.81E-03  1.87E-03  1.92E-03  1.98E-03 2.09E-03
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                              MAXIMUM RISK OR HAZARD TO MEI IN CATEGORY 7

                         CHLOROFORM: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 8.1 X 10E-2
N =  497
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH      100TH
RISK:       4.11E-05  6.49E-05  8.48E-05  1.07E-04  1.16E-04  1.26E-04  1.38E-04  1.47E-04  1.60E-04  1.77E-04

                          BENZENE: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 2.9 X 10E-2
N =  497
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH      100TH
RISK:       9.51E-06  1.07E-05  1.13E-05  1.19E-05  1.24E-05  1.28E-05  1.32E-05  1.37E-05  1.43E-05  1.51E-05

                       HEXACHLOROBENZENE: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 1.69
N =  497
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH      100TH
RISK:       8.99E-04  1.01E-03  1.07E-03  1.12E-03  1.17E-03  1.21E-03  1.25E-03  1.30E-03  1.35E-03  1.43E-03

                   TETRACHLOROETHANE: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 5.1 X 10E-2
N =  497
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH      100TH
RISK:       2.63E-05  2.95E-05  3.13E-05  3.29E-05  3.43E-05  3.55E-05  3.66E-05  3.79E-05  3.95E-05  4.17E-05

                2,4-DINITROTOLUENE: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 3.1  X 10E-1
N =  497
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH      100TH
RISK:       2.20E-04  2.47E-04  2.62E-04  2.75E-04  2.86E-04  2.97E-04  3.06E-04  3.17E-04  3.30E-04  3.49E-04

                          ARSENIC: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 1.5 X 10E1
N =  497
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH      100TH
RISK:       2.74E-05  3.08E-05  3.27E-05  3.43E-05  3.58E-05  3.71E-05  3.82E-05  3.96E-05  4.12E-05  4.30E-05

                         NITRATE: HAZARD = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) / 1.0 X 10E-1
N =  493
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH      100TH
RISK:       0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00

                                MAXIMUM AGGREGATE CARCINOGEN RISK TO MEI   CATEGORY 7
                           AGGREGATE RISK = SUM OF RISKS FROM THE FOLLOWING CONSTITUENTS:
                  CHLOROFORM, BENZENE, HEXACHLOROBENZENE, TETRACHLOROETHANE, 2,4 DINITROTOLUENE
N =  497
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH      100TH
RISK:       1.26E-03  1.39E-03  1.50E-03  1.57E-03  1.65E-03  1.71E-03  1.77E-03  1.85E-03  1.92E-03  2.05E-03
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                                   MAXIMUM RISK OR HAZARD TO MEI IN CATEGORY 8

                          CHLOROFORM: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 8.1 X 10E-2
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH      100TH
RISK:       4.88E-05  6.62E-05  8.13E-05  9.49E-05  1.10E-04  1.22E-04  1.36E-04  1.46E-04  1.53E-04 1.65E-04

                          BENZENE: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 5.2 X 10E-2
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH      100TH
RISK:       4.13E-06  5.72E-06  6.86E-06  8.19E-06  9.32E-06  1.05E-05  1.15E-05  1.22E-05  1.28E-05 1.38E-05

                          HEXACHLOROBENZENE; RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 1.69
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH      100TH
RISK:       3.91E-04  5.40E-04  6.48E-04  7.75E-04  8.81E-04  9.96E-04  1.08E-03  1.15E-03  1.21E-03 1.30E-03

                       TETRACHLOROETHANE: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 5.1 X 10E-2
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH      100TH
RISK:       1.14E-05  1.58E-05  1.89E-05  2.26E-05  2.58E-05  2.91E-05  3.17E-05  3.37E-05  3.55E-05 3.80E-05

                      2,4-DINITROTOLUENE: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 3.1  X 10E-1
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH      100TH
RISK:       9.54E-05  1.32E-04  1.58E-04  1.89E-04  2.15E-04  2.43E-04  2.65E-04  2.82E-04  2.96E-04 3.18E-04

                           ARSENIC: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 1.5 X 10E1
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH      100TH
RISK:       1.19E-05  1.65E-05  1.98E-05  2.36E-05  2.69E-05  3.04E-05  3.31E-05  3.52E-05  3.70E-05 3.97E-05

                          NITRATE: HAZARD = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) / 1.0 X 10E-1
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH      100TH
RISK:       0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00 5.25E-05

                                   MAXIMUM AGGREGATE CARCINOGEN RISK TO MEI - CATEGORY 8
                                AGGREGATE RISK = SUM OF RISKS FROM THE FOLLOWING CONSTITUENTS:
                        CHLOROFORM, BENZENE, HEXACHLOROBENZENE, TETRACHLOROETHANE, 2,4-DINITROTOLUENE
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH      100TH
RISK:       5.64E-04  7.80E-04  9.34E-04  1.12E-03  1.27E-03  1.42E-03  1.56E-03  1.66E-03  1.75E-03 1.87E-03
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                              MAXIMUM RISK OR HAZARD TO MEI IN CATEGORY 9

                  CHLOROFORM: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 8.1 X 10E-2
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       7.97E-05  9.86E-05  1.12E-04  1.21E-04  1.28E-04  1.35E-04  1.42E-04  1.49E-04  1.59E-04 1.76E-04

                   BENZENE: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 5.2 X 10E-2
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       9.75E-06  1.05E-05  1.10E-05  1.14E-05  1.18E-05  1.22E-05  1.26E-05  1.31E-05  1.36E-05 1.48E-05

                HEXACHLOROBENZENE: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 1.69
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       9.22E-04  9.93E-04  1.04E-03  1.07E-03  1.12E-03  1.15E-03  1.19E-03  1.24E-03  1.29E-03 1.40E-03

             TETRACHLOROETHANE: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 5.1 X 10E-2
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       2.70E-05  2.90E-05  3.03E-05  3.14E-05  3.26E-05  3.37E-05  3.49E-05  3.62E-05  3.76E-05 4.09E-05

            2.4-DINITROTOLUENE: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 3.1  X 10E-1
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       2.25E-04  2.42E-04  2.53E-04  2.62E-04  2.73E-04  2.82E-04  2.91E-04  3.02E-04  3.14E-04 3.42E-04

                   ARSENIC: RISK = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) X 1.5 X 10E1
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       2.81E-05  3.03E-05  3.16E-05  3.28E-05  3.41E-05  3.52E-05  3.64E-05  3.78E-05  3.92E-05 4.27E-05

                  NITRATE: HAZARD = (MAXIMUM WELL CONCENTRATION IN MG/L X 0.029) / 1.0 X 10E-1
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00 4.20E-08

                            MAXIMUM AGGREGATE CARCINOGEN RISK TO MEI - CATEGORY 9
                        AGGREGATE RISK = SUM OF RISKS FROM THE FOLLOWING CONSTITUENTS:
              CHLOROFORM, BENZENE, HEXACHLOROBENZENE, TETRACHLOROETHANE, 2.4-DINITROTOLUENE
N =  500
PERCENTILE:   10TH      20TH      30TH      40TH      50TH      60TH      70TH      80TH      90TH     100TH
RISK:       1.31E-03  1.40E-03  1.47E-03  1.53E-03  1.59E-03  1.65E-03  1.70E-03  1.77E-03  1.84E-03 2.01E-03
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APPENDIX 6.1

LINER MATERIAL SELECTION AND DESIGN CONSIDERATION

APPENDIX 6.1

LINER MATERIAL SELECTION AND DESIGN CONSIDERATIONS

Earthen, asphalt and concrete liners are some of the earliest types of lagoon sealers employed. While some of the rigid linings in this group have not enjoyed good reputations as hydraulic linings, they have a definite place in the technology. The structural stability of rigid linings complements the flexible systems which do not rate well in this respect. However, rigid systems cannot elongate to accomodate subgrade deformation as easily. Under certain conditions, some rigid systems may serve well as protective devices over other, more fragile, lining systems; in this application they have been most efficiently used.

Disadvantages of this category include sensitivity to low temperatures and frost penetration. Some admixed materials perform best when applied during periods of moderate temperatures, while asphalt concrete liners degrade when exposed to excessive heating conditions.

Soil-bentonite liners are easiest and least costly to repair when the breach can be identified and is relatively small. Because bentonite can absorb 5 times its weight in water and swell to 12-15 times its dry volume at maximum saturation, it is often used for filling voids in soil or repairing leaks. Draining of the liners requires dry conditions for proper adherence of the repaired section; however, repair of these materials is often more effective than repair of synthetic liners. Table 6.6-1 summarizes some of the basic characteristics of selected liners in this category (1,2,3,4,5,6 and 7).

Use of synthetic and rubber liners came into practice in the 1960s, and they have become increasingly popular in applications requiring essentially zero permeability. Table 6.1-2 lists some of the more common liners in this category together with their general characteristics. These materials are economical, resistant to most chemicals if selected and installed properly, available in large sheets simplifying installation, and essentially impermeable. As discharge standards continue to become more stringent, the application of plastic and elastomeric (the general name given to butyl rubber, neoprene and EPDM) membranes as lagoon liners will increase because of the need to guarantee protection against seepage. This is particularly true in the sealing of lagoons containing potentially toxic wastewaters.

Selection criteria for synthetic liners include the following:

o Chemical compatibility with lagoon waters. Wastewaters that are treated in municipal lagoons usually contain very dilute quantities of substances which may degrade liner materials. It has been found that, in cases where industrial wastes are accepted into an impoundment, aggressive chemicals can come into contact with and adversely affect some liners. Compatability testing of expected wastewater compositions and proposed liner materials must be conducted to ensure successful containment conditions.

Table 6.1-1

GENERAL CHARACTERISTICS OF SELECTED EARTHEN, ASPHALT AND CEMENT LINERS

Type of liner	Favorable Characteristics	Unfavorable Characteristics
Compacted soil	Longest record of sucessful performance. Economical. Flexibility provides resistance to normal subgrade settlement and minor seismic activity.	Controlled seepage. Variable soil characteristics affect construction practices. Interaction with certain wastes can affect properties. May be affected by freezing, thawing, drying, and wetting.
Concrete, unreinforced	Hard working surface which is easy to clean. Durable and resistant to freezing, thawing, wetting and drying.	Construction joints present leakage problems, field applied concrete membranes have widely varying degrees of permeability, and waterproofing categories tend to degrade with time. Vulnerable to actions of frost, swelling, and shrinkage within the soils on which they rest.
Gunite	Sprayed onto vertical surfaces without need for using forms, thus reducing cost. Application equipment is mobile, so inaccessible sites may be treated. Almost no demand as to the texture required in the subgrade.	Cracking during curing process and foundation settlement. A certain amount of seepage occurs due to cracks and porosity. Difficult to patch.
Asphalt concrete	May be used for the entire lining structure, or a principal part of a more complex lining. Depending on the mix, it may serve as an impermeable layer or as a porous layer.	Requires stable substrate. Subject to damage due to icing conditions. Interaction with certain wastes can affect properties. Can not be used on vertical slope work; use restricted to maximum slope of 2:1.
Prefabricated asphalt panels	Flexible, continuous, impervious, rugged in nature and resists vandalism. Generally tolerant to water solutions of most chemicals. Ability to form tough, long-lasting seals to concrete structures.	Panels are heavy and costs are fairly high. Panels exhibit flow properties on steep slopes in hot weather during their early life. Do not age well in desert areas of the country. Panels deteriorate on exposed berm areas.

SOURCE: References 2, 8, 9 and 10

Table 6.1-2

GENERAL CHARACTERISTICS OF SELECTED SYNTHETIC AND RUBBER LINERS

Type of liner	Favorable Characteristics	Unfavorable Characteristics
Polyvinyl chloride (PVC)	Most widely used liner material due to low initial cost and tolerance to a wide range of chemicals, oils, greases, and solvents. High strength-to-weight ratio and good resistance to puncture, abrasion, and microbiological activity.	Should be covered with soil because it is not as resistant to ozone, ultraviolet radiation, and weather deterioration as some of the other liners. Exposure to heat causes undesirable deterioration in presence of some chemicals. Becomes stiff at low temperatures, making installation and maintenance more difficult in cold weather.
Chlorinated polyethylene (CPE)	Not susceptible to ozone attack, and excellent resistance. Excellent resistance to atmospheric deterioration. Because it can be compounded with other plastics, it is a feasible base material for a broad spectrum of liners designed for specific applications.	Rather limited range of tolerance for chemicals, oils, and acids.
Hypalon (synthetic rubber)	Widely used and provides exceptional resistance to weather, ozone, and sunlight. Will not crack or fail at temperature extremes or from weathering. Highly resistant to a wide range of chemicals, acids, and alkalis. Moderate resistance to oils and growth of mold, mildew, fungus, and bacteria.	Relatively high cost and low tensile strength.
Ethylene propylene rubber (EPDM)	High strength, flexible compound. Highly impermeable; excellent resistance to weather and sunlight; resists abrasion tear and has a good tolerance for extremes of temperature. Resistant to dilute concentrations of acids, alkalis, silicates, phosphates, and brine.	Not recommended for hydrocarbons or for aromatic or halogenated solvents.
Neoprene (synthetic rubber)	Excellent resistance to oils, weathering and sunlight. Extremely resistant to puncture, abrasion, and mechanical damage. Resists hydrocarbons and acids. Primarily used for containment of wastewater and other liquid containing traces of hydrocarbons.	Expensive compared with other flexible liners. Difficult to seam and repair in the field.
Butyl (synthetic rubber)	Highly reliable with over 25 years of service in in storage of potable water. Good resistance to sunlight and ozone, extremely impermeable to water, retains flexibility, and high tolerance for temperature extremes. Good tear strength and resistance to puncture.	Low resistance to hydrocarbons and aromatic and halogenated solvents. Poor workability and seamability.

Table 6.1-2 , Continued

GENERAL CHARACTERISTICS OF SELECTED SYNTHETIC AND RUBBER LINERS

Type of liner	Favorable Characteristics	Unfavorable Characteristics
Polyethylene	Tough, highly flexible, and inert to solvents. Excellent low temperature qualities. Initial cost is relatively low.	Poor puncture resistance and weatherability; if not formulated correctly, protective soil covering may be necessary. Difficult to place and seam in the field.
Polypropylene	Tolerant to many chemicals and extremes of temperatures. Good tensile strength and low permeability to water.	Low resistance to sunlight if not formulated correctly. Difficult to seam in the field. Not recommended for containment of oxidizing solvents.
Elasticized Polyolefins	Resistant to weathering. Resistant to alkalis and acids.	Not resistant to oils. Not good in low temperature; is affected by wind.
Epichlorohydrin Rubbers	Resists hydrocarbon solvents, fuels, oils. Resists ozone and weathering. Low gas/vapor permeability. Exhibits thermal stability. Good tensile and tear strength. Retains flexibility.	Difficult to seam and repair in the field.
Nitrile Rubber	Resistant to oils Can be seamed and repaired in the field.	When compounded with plasticizers, becomes difficult to seam and repair in the field.
Chlorosulfonated Polyethylene	Resistant to ozone, UV light, heat, corrosive chemicals, mold, mildew, fungi, bacteria.	Thermoplastic type is sensitive to high temperatures. Hardens with age and is not resistant to oils. Unreinforced - low tensile strength, shrinks in heat. Mend to repair.

Source: References 1, 2, 8, 9, 10 and 11

- Resistance to extreme temperatures. In general, flexible membrane liners require mild temperatures for seaming, and some liners (e.g., polyvinyl chloride based liners) degrade when exposed to excessive heating conditions. If such conditions are expected, consideration should be given to selecting another liner (e.g., Hypalon) that is better able to withstand extreme temperatures.

- Resistance to ultraviolet light. Exposure of some flexible membrane pond linings to sunlight can cause degradation due to the effects of ultraviolet light. Polyvinyl chloride, polyethylene and polypropylene based liners are among those not recommended for use when the liner may be exposed to the weather for a long period of time before filling. Dike slopes and other exposed areas whould be protected by a soil cover to reduce the effects of sunlight on ultraviolet-sensitive materials. Exposable materials include the synthetic rubbers (butyl, EPDM, Hypalon and neoprene).

- High tensile strength, flexibility, and the ability to conform to minor subrade deformations without failure. While flexible membrane liners can offer significant advantages with regard to flexibility and relative impermeability, they are relatively fragile when compared to the more rigid admixed materials.

- Resistance to abrasion, puncture, bacterial and fungal attack. The minimum recommended thickness is 20 mils. The material should exhibit good weatherability, with a manufacturer's guarantee of long life (20-30 years). The life expectancy of the liner system of a surface impoundment is extremely dependent on design, construction quality and consistent maintenance.

- Specific gravity greater than 1.0. If a liner material does not meet this criterion, it will not be held in place by the weight of lagoon liquids.

- Ease of installation. Liner installation must be evaluated on a case-by-case basis. The relative ease of installation will depend on such factors as design (above-grade, below-grade, or combination); the availability of usable low-permeability materials for the subgrade and/or liner; seaming requirements; and weather.

- Ease of repair. Flexible membrane liners are not as easily repaired as soil-bentonite liners. At the very least, the pond will require draining prior to effecting the repair and may require replacement of a panel or the entire liner.

- Relative cost and availability. Transportation and delivery costs must be taken into account in any comparison of liner material, particularly when choosing between admixed and synthetic liners. For example, clay may appear cheaper than a given synthetic liner on the basis of material costs; however, transport costs for the former may tip the balance in favor of the synthetic liner.

In addition to use of admixed and synthetic/rubber liners, ponds can be sealed, either separately or in combination, by natural means or by chemical treatment (2). Natural sealing of ponds has been found to occur from three mechanisms: (1) physical clogging of soil pores by settled solids; (2) chemical clogging of soil pores by ionic exchange; and (3) biological and organic clogging caused by microbial growth at the pond lining. The dominant mechanism of the three depends on the characteristics of the wastewater being treated. Chemical treatment changes the nature of the bottom soil to ensure sealing.

Chemicals have also been used for some time as a means of stabilizing soils. Although these techniques are aimed at reducing porosity, their primary objective has been to increase soil stability and/or bearing capacity. Sealants used include: (1) polymer-diesel mixtures; (2) petroleum-based emulsions; (3) powdered polymers which form a gel after application; and (4) monovalent cationic salts. These agents can be water-borne, spray-applied, mixed in place, or injected below the ground surface (1). There is little information in the literature regarding the use of chemicals for reduction of seepage. Among the several reasons for the lack of popularity of chemical treatments as linings, three are important: (1) they are not 100 percent effective and often are not effective at all; (2) they are complex and not well understood; and (3) usually they are expensive, although there are a few exceptions (8).

Each lining material discussed in this section has certain advantages and disadvantages. No single liner has all the attributes that would make it the ideal material. The concept of combination liners makes use of various combinations that would place each component in the location where its desirable properties could be used most efficiently (8).

The best example of a combination liner that has been widely used in the past is that of a continuous impervious lining overlaid with a concrete, gunite, or asphalt concrete topping. Although this liner combination is effective, it is rather costly, and consequently it has given way in recent years to other combinations.

A second general type of combination system that has been used in the lining field involves the use of a combination of flexible liner materials. For example, the exposed portion of a liner (i.e., berms, embankments) could be fabricated of a highly weather-resistant, and possibly less expensive, material.

Combination systems also have involved continuous membranes in combination with low permeability clays. In this application, the lining often serves a dual role of seepage control and wave erosion control.

APPENDIX 6.2

LAGOON CONSTRUCTION

APPENDIX 6.2

LAGOON CONSTRUCTION

6.2.1 SUBGRADE PREPARATION

The compaction of soil is an essential step in the construction of all types of liners whether it is soil for a soil-clay liner or for a subgrade upon which admixed or flexible membrane liners will be installed. The equipment, depth, number of lifts, and degree of compaction will be specified by engineering design. The soil type and moisture content will be tested to determine the methods of achieving the desired permeability. The installation of both admixed and synthetic liners can be quite sensitive to small deformations in the subgrade. The liner should be emplaced before the subgrade can be damaged by wind or rainfall, particularly if a synthetic liner will be used. In general, the smoother the surface of the impoundment prior to liner placement, the greater the potential for successful lagoon performance (1, 2, 4, 5, 6 and 7).

6.2.2 LINER INSTALLATION

Installation procedures for admixed material liners are site and material-specific. In general, in-situ soils are mixed with the liner material and applied to the lagoon surface in a continuous or overlapping manner. Soil cement and asphalt cement may be placed by road paving equipment; hot asphalt is spray-applied, and concrete and gunite are placed using a slip or screen. Bentonite is mixed with soil, spread and compacted. Variations in materials and application methods are numerous and new technologies are regularly being introduced (1,2,4,5 and 6).

Synthetic liner panels are delivered to the lagoon site either folded or in rolls. Depending on the specific liner material, seams are sealed using adhesive(s) solvent(s), bodied solvents, heat guns, and other thermal techniques, cements, or tape. Quality control during seaming is vital to ensure adequate strength and permeability of the seal. All inlets, outlets and other penetrations must be sealed to prevent leakage. Past experience indicates that it is very difficult to be sure that all seams are sealed properly to assure long-term integrity of the liner system.

Protective soil covers are provided in many cases to anchor and protect the synthetic liner from degration. Ultraviolet light and ozone are damaging to some liners (e.g., polyvinyl chloride) and the effects of excessive heat or cold can cause others to become brittle or to lose their impermeability. Soil covers are recommended for dike slopes to aid in resisting mechanical damage and slippage.

Proper anchoring of the liner around the impoundment perimeter as well as conscientious tailoring and sealing of the liner around penetrating structures is essential to satisfactory liner performance. The most common anchoring method for the perimeter is "trench-and-backfill." A trench is excavated along the top of the dike or beam and the liner edges are emplaced. After seaming has been completed and the panel is proper spread and smoothed, the trench is then backfilled to secure the liner (1,3 and 7).

APPENDIX 6.3

COSTS

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LAGOONS, AERATED

FACT SHEET 2.1.11

Description - Aerated lagoons are medium-depth basins designed for the biological treatment of wastewater on a continuous basis. In contrast to stabilization ponds, which obtain oxygen from photosynthesis and surface re-aeration, they employ aeration devices which supply supplemental oxygen to the system. The aeration devices may be mechanical (i.e., surface aerator), or diffused air systems. Surface aerators are divided into two types: cage aerators and the more common turbine and vertical shaft aerators. The many diffused air systems utilized in lagoons consist of plastic pipes supported near the bottom of the cells with regularly spaced sparger holes drilled in the tops of the pipes. Because aerated lagoons are normally designed to achieve partial mixing only, aerobic-anaerobic stratification will occur, and a large fraction of the incoming solids and a large fraction of the biological solids produced from waste conversion settle to the bottom of the lagoon cells. As the solids begin to build up, a portion will undergo anaerobic decomposition. Volatile toxics can potentially be removed by the aeration process, and incidental removal of other toxics can be expected to be similar to an activated sludge system. Several smaller aerated lagoon cells in series are more effective than one large cell. Tapering aeration intensity downward in the direction of flow promotes settling out of solids in the last cell. A non-aerated polishing cell following the last aerated cell is an optional, but recommended, design technique to enhance suspended solids removal prior to discharge.

Common Modifications - The lagoons may be lined with concrete or an impervious flexible lining, depending on soil conditions and environmental regulations. Use of various types of aeration. When high-intensity aeration produces completely mixed (all aerobic) conditions, a final settling tank is required. Solids are recycled to maintain about 800 mg/l MLVSS in this mode.

Technology Status - While not as widely used when compared with the large number of stabilization ponds in common use throughout the U. S., it has been fully demonstrated, and used for years.

Applications - Used for domestic and industrial wastewater of low and medium strength. Commonly used where land is inexpensive and costs and operational control are to be minimized. It is relatively simple to upgrade existing oxidation ponds, lagoons, and natural bodies of water to this type of treatment. Aeration increases the oxidation capacity of the pond and is useful in overloaded ponds that generate odors. Useful when supplemental oxygen requirements are high or when the requirements are either seasonal or intermittent.

Limitations - In very cold climates aerated lagoons may experience reduced biological activity and treatment efficiency, and the formation of ice.

Typical Equipment/No. Mfrs. (23) - Lining systems/6; Aerators/30; Hydraulic Controls/29

Performance

	Influent	% Removed
BOD	200 - 500 mg/l	60 - 90
COD	-	70 - 90
TSS	200 - 500 mg/l	70 - 90

Residuals - Settled solids on pond bottom may require clean-out every 10 to 20 years, or possibly more often if a polishing pond is used behind the aerated pond.

Design Criteria (12, 67)

Operation: One or more aerated cells, followed by a settling (unaerated) cell
Detention time: 3 to 10 days
Depth, ft: 6 to 20
pH: 6.5 to 8.0

Water Temperature range: 0 to 40°C
Optimum Water Temperature: 20°C
Oxygen requirement: 0.7 to 1.4 times the amount of BOD_5 removed
Organic Loading: 10 to 300 lb BOD_5/acre/d

Energy requirements:
- For aeration: 6 to 10 hp/million gallons capacity
- To maintain all solids in suspension: 60 to 100 hp/million gallons capacity
- To maintain some solids in suspension: 30 to 40 hp/million gallons capacity

Process Reliability - The service life of a lagoon is estimated at 30 years or more. The reliability of equipment and the process is high. Little operator expertise is required.

Environmental Impacts - There is opportunity for volatile organic material and pathogens in aerated lagoons to enter the air as with any aerated wastewater treatment process. This opportunity depends on air/water contact afforded by the aeration system. There is potential for seepage of wastewater into ground water unless a lagoon is lined. Compared to other secondary treatment processes, aerated lagoons generate less solid residue.

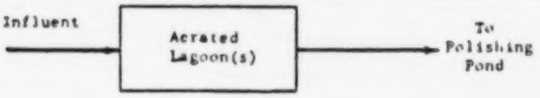
Toxics - Volatile toxics will be removed, and incidental removal of other toxics can be expected to be similar to an activated sludge system.

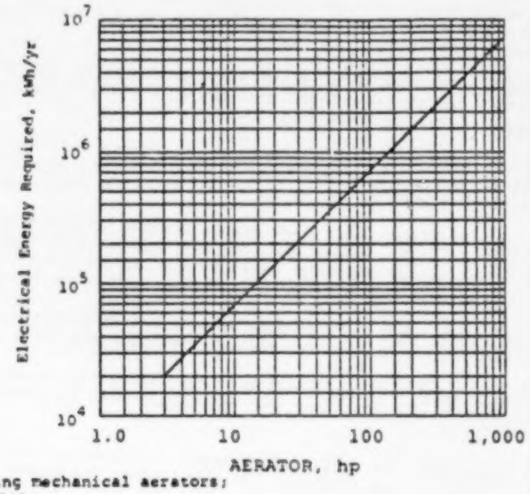
References - 7, 12, 13, 18, 23, 67

Source: Reference 12

LAGOONS, AERATED FACT SHEET 2.1.11

FLOW DIAGRAM -





ENERGY NOTES (4) -
Low speed mechanical surface aerators; motor efficiency = 90%; aerator efficiency = 1.8 lb O_2/hph (wire to water); head loss negligible. Type of energy required: electrical

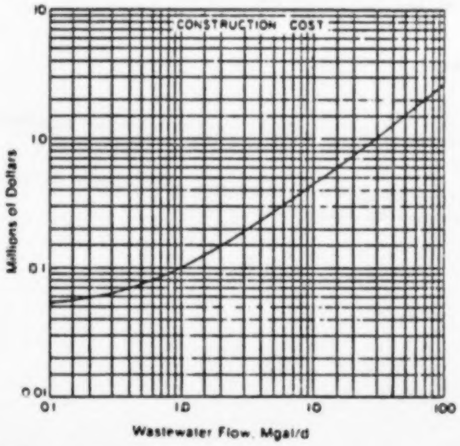
For additional information on energy requirements and transfer efficiency of selected aeration devices, refer to Table D-1.

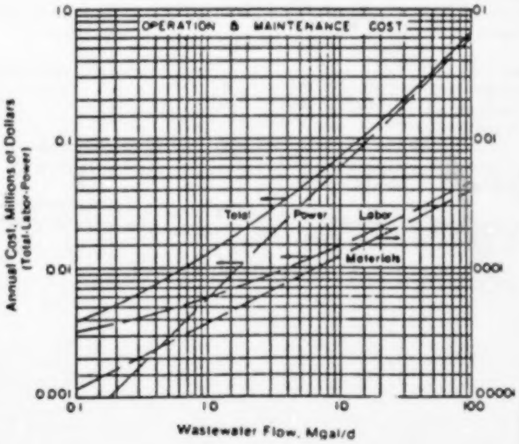
COSTS* (3) -Assumptions:
1. Service life, 30 years; ENR Index = 2475
2. Theoretical detention time = 7 d; 15-ft water depth; floating mechanical aerators;
3. Horsepower required = 36 hp/Mgal of capacity; power @ $.02/kWh;
4. Construction cost includes excavation, embankment, and seeding of lagoon/slopes (3 cells); service road and fencing; riprap embankment protection; hydraulic control works; aeration equipment and electrical equipment.

Wastewater Characteristics:	In	Out
BOD_5, mg/l	210	25
COD, mg/l	400	50
TSS, mg/l	230	40
Total-P, mg/l	11	8
NH_3-N, mg/l	20	18

To adjust construction cost for detention time other than above, enter curve at effective flow (Q_E)

$$Q_E = Q_{DESIGN} \times \frac{\text{New Design Detention Time}}{\text{7 days}}$$





REFERENCES - 3, 4

*To convert construction cost to capital cost see Table A-2.

Source: Reference 12

LAGOONS, FACULTATIVE

.FACT SHEET 2.1.13

Description - Facultative lagoons are intermediate depth (3 to 8 feet) ponds in which the wastewater is stratified into three zones. These zones consist of an anaerobic bottom layer, an aerobic surface layer, and an intermediate zone. Stratification is a result of solids settling and temperature-water density variations. Oxygen in the surface stabilization zone is provided by reaeration and photosynthesis. This is in contrast to aerated lagoons in which mechanical aeration is used to create aerobic surface conditions. In general, the aerobic surface layer serves to reduce odors while providing treatment of soluble organic by-products of the anaerobic processes operating at the bottom.

Sludge at the bottom of facultative lagoons will undergo anaerobic digestion producing carbon dioxide, methane and cells. The photosynthetic activity at the lagoon surface produces oxygen diurnally, increasing the dissolved oxygen during daylight hours, while surface oxygen is depleted at night.

Facultative lagoons are often and for optimum performance should be operated in series. When three or more cells are linked, the effluent from either the second or third cell may be recirculated to the first. Recirculation rates of 0.5 to 2.0 times the plant flow have been used to improve overall performance.

Common Modifications - Facultative lagoons are customarily contained within earthen dikes. Depending on soil characteristics, lining with various impervious materials such as rubber, plastic or clay may be necessary. Use of supplemental top layer aeration can improve overall treatment capacity, particularly in northern climates where icing over of facultative lagoons is common in the winter.

Technology Status -Fully demonstrated and in moderate use especially for treatment of relatively weak municipal wastewater in areas where real estate costs are not a restricting factor.

Applications - Used for treating raw, screened, or primary settled domestic wastewaters and weak biodegradable industrial wastewaters. Most applicable when land costs are low and operation and maintenance costs are to be minimized.

Limitations - In very cold climates, facultative lagoons may experience reduced biological activity and treatment efficiency. Ice formation can also hamper operations. In overloading situations, odors can be a problem.

Typical Equipment/No. of Mfrs. (23) - Lining systems/6; Hydraulic controls/29.

Performance - BOD_5 reductions of 75 to 95 percent have been reported. Effluent suspended solids concentrations of 20 to 150 mg/l can be expected, depending on the degree of algae separation achieved in the last cell. Efficiencies are strongly related to pond depth, detention time and temperature.

Chemicals Required - If wastewater is nutrient deficient, a source of supplemental nitrogen or phosphorus may be needed. No other chemicals are required.

Residuals - Settled solids may require clean out and removal once every 10 to 20 years.

Design Criteria -
Operation: At least three cells in series. Parallel trains of cells may be used for larger systems.
Detention time: 20 to 180 days.
Depth, ft: 3 to 8, although a portion of the anaerobic zone of the first cell may be up to 12 ft deep to accommodate large initial solids deposition.
pH: 6.5 to 9.0
Water temperature range: 35 to 90°F for municipal applications
Optimum water temperature: 68°F
Organic loading: 10 to 100 lb BOD_5/acre/d

Process Reliability - The service life of the lagoon is estimated to be 50 years. Little operator expertise is required. Overall, the system is highly reliable.

Environmental Impact - There is potential for seepage of wastewater into ground water unless lagoon is lined. Compared to other secondary processes, relatively small quantities of sludge are produced.

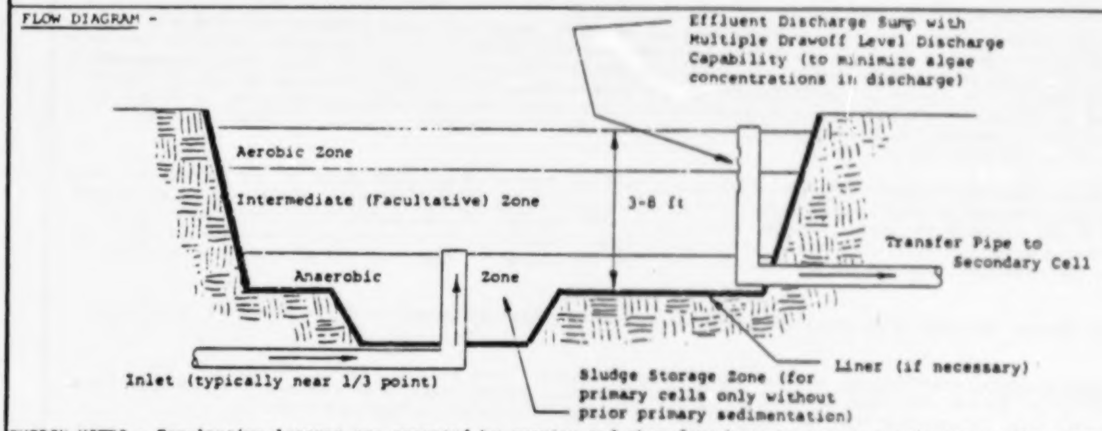
References - 3, 7, 18, 23, 67, 109, 110

Source: Reference 12

LAGOONS, FACULTATIVE

FACT SHEET 2.1.13

FLOW DIAGRAM -


Effluent Discharge Sump with Multiple Drawoff Level Discharge Capability (to minimize algae concentrations in discharge)
Aerobic Zone
Intermediate (Facultative) Zone
3-8 ft
Transfer Pipe to Secondary Cell
Anaerobic
Zone
Liner (if necessary)
Inlet (typically near 1/3 point)
Sludge Storage Zone (for primary cells only without prior primary sedimentation)

ENERGY NOTES - Facultative lagoons are operated by gravity and therefore have no energy requirements other than any pumping that may be necessary to lift the influent wastewater into the lagoons.

COSTS* - Assumptions:

1. Warm climate - lagoon loading = 40 lb BOD_5/acre/d.
2. Cool climate (northern U.S.) - lagoon loading = 20 lb BOD_5/acre/d.
3. Water depth = 4 ft.
4. Construction cost includes excavating, grading, and other earthwork required for normal subgrade preparation and service roads. Costs do not include land and pumping.
5. Process performance:

	Wastewater Characteristics	
	In	Out
BOD_5, mg/l	210	30
COD, mg/l	400	100
TSS, mg/l	230	60
Total-P, mg/l	11	8
NH_3-N, mg/l	20	15 (cool climate) 1 (warm climate)

6. No liner included in cost estimate.
7. ENR Index = 2475

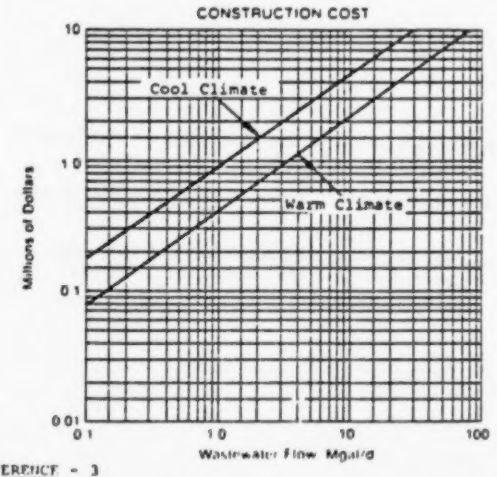
Adjustment Factor: To adjust costs for loadings other than those above, enter curve at effective flow (Q_E).

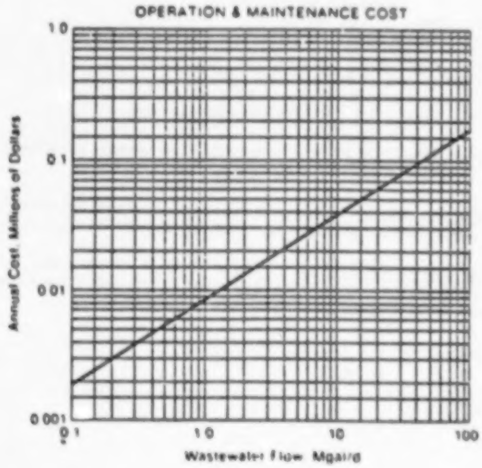
Warm Climates

$$Q_E = Q_{DESIGN} \times \frac{40 \text{ lb } BOD_5\text{/acre/day}}{\text{New Design Loading}}$$

Cool Climates

$$Q_E = Q_{DESIGN} \times \frac{20 \text{ lb } BOD_5\text{/acre/day}}{\text{New Design Loading}}$$





REFERENCE - 3

*To convert construction cost to capital cost see Table A-2.

Source: Reference 12

LAGOONS, ANAEROBIC   FACT SHEET 2.1.12

Description - Anaerobic lagoons are relatively deep (up to 20 ft) ponds with steep sidewalls in which anaerobic conditions are maintained by keeping loading so high that complete deoxygenation is prevalent. Although some oxygenation is possible in a shallow surface zone, once greases form an impervious surface layer, complete anaerobic conditions develop. Treatment or stabilization results from thermophilic anaerobic digestion of organic wastes. The treatment process is analogous to that occurring in single stage untreated anaerobic digestion of sludge in which acid forming bacteria break down organics. The resultant acids are then converted to carbon dioxide, methane, cells and other end products.

In the typical anaerobic lagoon, raw wastewater enters near the bottom of the pond (often at the center) and mixes with the active microbial mass in the sludge blanket, which is usually about 6 ft deep. The discharge is located near one of the sides of the pond, submerged below the liquid surface. Excess undigested grease floats to the top, forming a heat retaining and relatively air tight cover. Wastewater flow equalization and heating are generally not practiced. Excess sludge is washed out with the effluent. Recirculation of waste sludge is not required.

Anaerobic lagoons are capable of providing treatment of high strength wastewaters and are resistant to shock loads.

Common Modifications- Anaerobic lagoons are customarily contained within earthen dikes. Depending on soil characteristics, lining with various impervious materials such as rubber, plastic or clay may be necessary. Pond geometry may vary, but surface area to volume ratios are minimized to enhance heat retention.

Technology Status - Although anaerobic processes are common for sludge digestion, anaerobic lagoons for wastewater treatment have found only limited application. The process is well demonstrated for stabilization of highly concentrated organic wastes.

Typical Equipment/No.of Mfrs.(23) -

Lining Systems/6; Hydraulic controls/29

Applications - Typically used in series with aerobic or facultative lagoons. Anaerobic lagoons are effective as roughing units prior to aerobic treatment of high strength wastes.

Limitations - May generate odors. Requires relatively large land area. For efficient operation, water temperatures above 75°F should be maintained.

Performance - BOD_5 removals of 50 to 70 percent are achievable depending on loading and temperature conditions. TSS concentrations may increase, especially if the influent BOD_5 is primarily dissolved. Generally does not produce an effluent suitable for direct discharge to receiving waters.

Residuals Generated - In anaerobic lagoons excess sludge is usually washed out in the effluent. Since anaerobic lagoons are often used for preliminary treatment recirculation or removal of sludge not generally required.

Chemicals Required - Nutrients as needed to make up deficiencies in raw wastewater. No other chemicals required.

Design Criteria -

Operation: Parallel or series
Detention Time: 20 to 50 d
Depth, ft: 8 to 20
pH: 6.8 to 7.2
Water Temperature Range: 35 to 120°F
Optimum Water Temperature: 86°F
Organic loading: 200 to 2200 lb BOD_5/acre/d

Unit Process Reliability - Generally resistant to upsets. Highly reliable if pH in the relatively narrow optimum range is maintained.

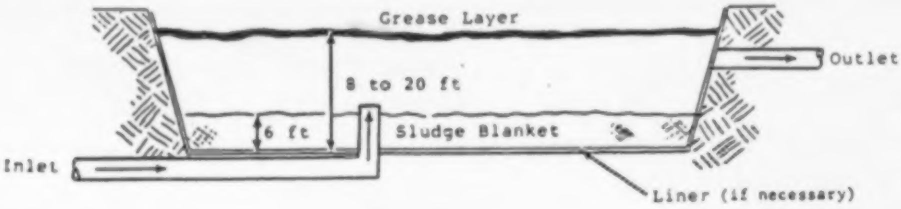
Environmental Impact - May create odors. Have relatively high land requirements. There is potential for seepage of wastewater into groundwater unless lagoon is lined.

Joint Treatment Potential - Valuable as a preliminary treatment process for combined industrial and municipal wastes containing high concentrations of organic materials. Can be used preceding most standard biological treatment processes.

References - 7, 16, 18, 20, 23, 67, 107, 110

Source: Reference 12

FLOW DIAGRAM -



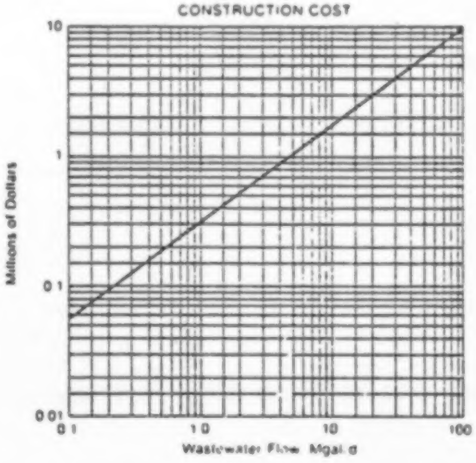
ENERGY NOTES - Anaerobic lagoons are operated by gravity flow and therefore have no energy requirements other than any pumping that may be necessary to lift the influent wastewater into the lagoons.

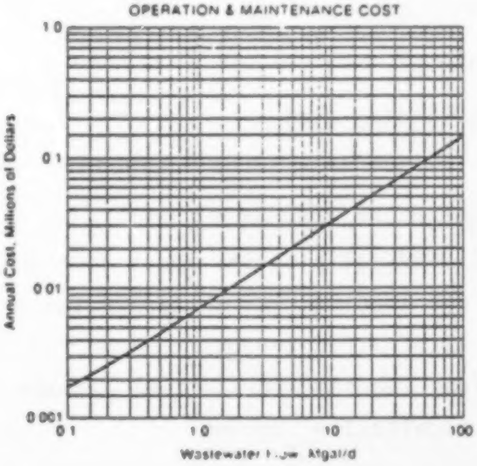
COSTS* - Assumptions: January 1979 dollars; ENR Index = 2872.
Service Life: 50 years
Average detention time = 35 days; depth = 10 ft; BOD_5 loading = 466 lb/acre/d. Construction cost includes excavating, grading and other earthwork and service roads. Costs do not include land and pumping. Liner cost not included in estimate. Operation and maintenance costs consist of labor and material.

Wastewater Characteristics	Influent, mg/l	Effluent, mg/l
BOD_5	600	240

To adjust costs for other BOD_5 loadings and/or detention times, enter curve at effective flow (Q_E):

$$Q_E = Q_{DESIGN} \times \frac{(466\ \text{lb/acre/d})(\text{New detention time})}{(\text{New Design Loading})\ (35\ \text{days})}$$


CONSTRUCTION COST


OPERATION & MAINTENANCE COST

REFERENCE - Curves derived from reference 3.

*To convert construction cost to capital cost see Table A-2.

Soruce: Reference 12

TABLE 6.3-1

DEVELOPMENT OF CAPITAL COSTS

	Cost[a]	
Category	Warm Climate[b]	Cool Climate[c]
Component Installed Construction Costs	$142,000	$319,000
Subtotal 1	142,000	319,000
Non-Component Construction Costs		
Piping @ 10%	14,000	32,000
Electrical @ 8%	11,000	26,000
Instrumentation @ 5%	7,000	16,000
Site Preparation @ 5%	7,000	16,000
Subtotal 2	39,000	90,000
Non-Construction Costs		
Engineering and Construction Supervision @ 15%	27,000	61,000
Contingencies @ 15%	27,000	61,000
Subtotal 3	54,000	122,000
TOTAL CAPITAL COST	$235,000	$531,000

SOURCE: After Reference 12

[a] June 1987 dollars; ENR Index 4386.80

[b] Surface loading rate in warm climate is assumed to be 40 lb BOD_5/acre/day for facultative lagoons

[c] Surface loading rate in cool climate is assumed to be 20 lb BOD_5/acre/day for facultative lagoons

TABLE 6.3-2

COSTS OF SELECTED FLEXIBLE MEMBRANE LINERS

Material	Nominal Thickness (mils)	Price ($\$/\text{yd}^2$)[a]	
		Relative Cost[b]	Installed Cost[c]
Butyl Rubber	30	M	6.68-7.99[d,e]
Chlorinated Polyethylene (CPE)	30	M	7.31-12.60[d,e]
Chlorosulfonated Polyethylene (CSPE)	30	M	7.31-12.60[d,e]
Elasticized Polyolefins (ELPO)	20	-	3.52-3.83
Ethylene Propylene Rubber	30	M	6.68-7.99[d,e]
Neoprene	30	H	9.95-11.48[e]
High Density Polyethylene (HDPE)	60	M-H[f]	8.17[d]
	80		9.07-9.64[d]
Epichlorohydrin Rubbers	-	H	8.48-12.72
Polyvinyl Chloride (PVC)	20	L	2.45-3.37
	30		3.06-4.17

Source: References 1 and 13

[a] June 1987 dollars; ENR Index of 4386.80

[b] L=low; M=moderate; H=high

[c] Installed cost is highly dependent on the area being lined.

[d] Includes subgrade preparation

[e] Includes fabric reinforcement

[f] Depends on thickness

TABLE 6.3-3

COSTS OF SELECTED EARTHEN AND ADMIXED LINERS

Material	Installed Cost ($\$/yd^2$)[a,b,c]
Soil and Bentonite (9 lb/yd^2)	1.72
Bentonite	1.53 - 3.52
Soil Cement (6 inches plus 2 coats sealer)	2.97
Gunite	6.12 - 22.95
Soil Asphalt (6 inches plus 2 coats sealer)	2.97
Asphalt Panels	9.79 - 16.37
Hydraulic Asphalt Concrete (hot mix, 4 inches)	7.15 - 10.02

Source: References 1 and 2

[a] June 1987 dollars; ENR Index of 4386.80

[b] Does not include subgrade preparation

[c] Transportation costs will vary depending on distance of site from material source

APPENDIX 6.3

TABLE 6.3-4

COSTS FOR A FOUR-WELL GROUND-WATER MONITORING SYSTEM

Item	Cost Per Well	System Cost
INSTALLATION AND DEVELOPMENT COSTS (exclusive of supervisory personnel)		
Mobilization/Demobilization	$125.00	$500.00
Drilling		
- 10-inch hollow stem auger @ $20.00/ft and 40 ft.	800.00	3,200.00
- Split-spoon sampling @ $75.00/sample and 5-ft. intervals	675.00	2,700.00
Well Installation (4-inch Schedule 80 PVC pipe)		
- Well casing (blank) @ $11.00/ft and 35 ft	385.00	1,540.00
- Well screen @ $20.00/ft and 10 ft	200.00	800.00
- Backfill (clean sand filter pack, bentonite seal, grout and cement) @ $14.00/ft	560.00	2,240.00
- Protective locking well cover	300.00	1,200.00
- Equipment decontamination (one hour)	150.00	600.00
Well Development @$150.00/hr and 1 hr/well	150.00	600.00
TOTAL	$3,345.00	$13,380.00

TABLE 6.3-4 (Continued)

COSTS FOR A FOUR-WELL GROUND-WATER MONITORING SYSTEM

Item	Cost Per Well	System Cost
SUPERVISORY COSTS (during well installation)		
Supervisory Personnel		
- Geologist @$40.00/hr and 8-12 hr/well	400.00	1,600.00
- Rental Car @$50.00/day	50.00	200.00
- Per diem @$75.00/day	75.00	300.00
TOTAL	525.00	2,100.00
SAMPLING AND ANALYSIS COSTS		
Sampling (2 people)		
- Pre-sample purge @$30.00/manhour and 1-2 hrs/well	90.00	360.00
- Sampling equipment, containers, protective clothing (Level D), field instrument rental, sample shipment costs	80.00	320.00
- Rental car @$50.00/day	50.00	50.00
- Per diem @$75.00/manday	150.00	150.00
Analysis		
- Priority pollutant scan @$2,000.00/sample	2,000.00	8,000.00
- QA/QC (field blank, wash blank)[a]	2,000.00	2,000.00
TOTAL (per sampling event)	$4,370.00	$10,880.00

[a] One QA/QC sample per sampling event, whether one or four wells.

APPENDIX 6.4

PRETREATMENT

APPENDIX 6.4

TABLE 6.4-1

ESTABLISHED PRETREATMENT PROCESSES

Process[a]	TYPES OF WASTES TREATED								
	Amines	Cyanide	Ethers	Halogenated Organics (Non-Volatile)	Metals	Phenols	Phthalates	Poly-nuclear Aromatics	Volatile Organics
Adsorption	X	X	X	X	X	X	X	X	X
Evaporation	X	0	X	-	X	-	-	-	-
Filtration	-	-	-	-	X	-	X	-	-
Flocculation	-	-	-	-	X	-	-	-	-
Neutralization	-	-	-	-	X	-	-	-	-
Precipitation	-	0	-	-	X	-	X	0	-
Sedimentation	-	-	X	-	X	-	-	-	-
Stripping	-	0	-	-	0	X	-	-	X
Aerobic Bio Treatment[b]	X	-	X	-	-	X	X	X	X
Anaerobic Bio Treatment[b]	X	-	X	-	-	X	X	X	X

[a] Because these processes would be used to treat industrial wastewater prior to discharge to the POTW, costs will vary significantly depending upon: (1) the particular chemical(s) to be removed from the industrial wastestream; (2) the magnitude of flow to be treated; and (3) the particular discharge limits to be met.

[b] Should only be used as a general guide. Specific compounds may or may not be biodegradable depending upon concentration and environmental conditions such as the presence of toxic substances.

X: Compounds amenable to treatment.
0: Compounds not amenable to treatment.
-: Information not available.

Source: References 14, 15 and 16

APPENDIX 6.5

LAGOON REMEDIATION

APPENDIX 6.5

TABLE 6.5-1

GENERAL TYPES OF RESPONSE ALTERNATIVES APPLICABLE TO MUNICIPAL LAGOONS

ACTION
No action (periodic monitoring)
Construction of alternate water supply (in response to a short-term health threat)
Source Control
o Retrofit/repair lagoon to eliminate pollutant source
o Clean closure (removal of waste)
o Closure with waste in place
Landfill of excavated material
Incineration of excavated material
Control of contaminant plume
o Ground-water extraction and treatment
o Ground-water diversion
o In-situ treatment (innovative)
o Allow natural attenuation through dilution, sorption and degradation

APPENDIX 6.5

TABLE 6.5-2

REMEDIAL TECHNOLOGIES

Remedial Technology	Comments
Removal of wastewater	o Necessary for all alternatives except no action and bentonite liner repair.
Mechanical dewatering of excavated sediments/sludges	o Gravity sedimentation yields lowest solids and requires greatest area. o Centrifuges and filtration units are available in mobile systems. o All processes generate an effluent which requires proper treatment/disposal.
Excavation of sludge and soil (Backfill, compaction/grading and revegetation).	o If contamination is deep, the resulting depth of excavation may be such as to require significant bracing and dewatering (and potential treatment of extracted water).
Landfill of excavated materials	o Landfill is generally cheaper than incineration. o On-site landfill must be permitted or otherwise approved by regulatory authorities, and may require long-term monitoring and maintenance. (However, liability is contained on site.) o Off-site landfill requires transport and extends potential liability.
Incineration of excavated materials	o More expensive than landfill. o Off-site incineration requires transport. o On-site incineration requires permitting and is cost-effective only for large quantities.
Site capping, grading and revegetation	o Designed to minimize infiltration and leachate generation when waste (e.g., contaminated soil) is left in place. o Wastewater must be removed. o Requires long-term maintenance to ensure integrity. o Major disadvantages of a surface cap are its uncertain design life and the need to monitor ground water. o Capping is usually less expensive than excavation.
Surface water diversion and collection	o Can be used temporarily to divert surface water around a site during excavation or other remedial activity. Some types of diversion structures (e.g., sodded or stone waterways) are permanent. o Requires inspection and maintenance.
Ground-water Extraction - Subsurface Drainage Systems	o Less expensive than pumping if contamination is shallow and hydraulic conductivities are variable or low. o In general, O&M costs are lower than for pumping, and system is easier to operate. o Limited to shallow depths. o Can clog in the presence of reactive or viscous chemicals. o Construction/installation (i.e., excavation) costs are greater than for pumping. Installation period is longer and thus the system is not appropriate for immediate remediation. o Costly to repair.
Ground-water Extraction - Wells	o Better than subsurface drainage systems when contaminants are miscible and move readily with ground water, the hydraulic gradient is steep, and the hydraulic conductivity is high. o Can be used in combination with slurry walls (slurry wall can divert uncontaminated ground water around the site, thus minimizing the amount to be extracted). o High O&M costs. o Requires facilities for storage, treatment and/or disposal of extracted ground water.

TABLE 6.5-2, Continued

REMEDIAL TECHNOLOGIES

Remedial Technology	Comments
Ground-water Injection	o Injection wells can be used to direct contaminants toward extraction wells (useful when quick removal is desired and hydraulic gradient is relatively low). o Requires frequent maintenance and well rehabilitation. o Can help redirect plume away from an exposure point.
Ground-water barriers - Slurry wall (soil-bentonite, cement-bentonite, or diaphragm walls)	o Requires little or no maintenance. o Less expensive than grouting. o Easy to construct. o Results in immediate control of ground-water levels if properly designed and installed. o When combined with extraction wells, can be used to maintain an inward hydraulic gradient. o Can be susceptible to tunneling as a result of cation exchange with calcium-rich ground water.
Ground-water barriers - Rock grouting and grout curtains (Portland cement and clay are the two most common grouts)	o Better than slurry for sealing voids in rock. o Minimal O&M. o More expensive than slurry walls. o Cannot achieve uniformly low permeability in unconsolidated materials. o Requires specialized equipment, resulting in a large mobilization cost.
Ground-water barriers - Sheet piling	o Used for temporary dewatering during other construction/excavation or as erosion protection for another barrier. o Little maintenance. o Subject to corrosion unless protected. o Can be damaged during installation.
Ground-water treatment	o Can be done on site with both fixed and mobile systems. o See Table 6.3-3 for individual processes.

Source: References 13 and 15.

APPENDIX 6.5

TABLE 6.5-3

COMMON GROUND-WATER TREATMENT PROCESSES

Treatment Process	Comments
Activated Carbon	o Well-suited for the removal of mixed organics, especially if they are hydrophobic and nonpolar. Can also remove some metal and inorganic species. o If fulvic or humic acids are present, they will preferentially adsorb and result in rapid carbon exhaustion. o Requires pretreatment for oil and grease and suspended solids. o Often used following air stripping. o Mobile systems are commercially available, easy to start up and shut down, and require minimal space. o Not affected by toxic compounds. o High capital and operating costs can be reduced by pretreatment (e.g., sedimentation, biological treatment, and/or air stripping).
Biological Treatment (suspended growth and fixed-film systems)	o Degrades soluble organics more readily than insoluble organics. o Halogenated and nitro-substituted compounds are generally more refractory than other materials. o Bacteria can be inhibited by toxic compounds (e.g., metals) and shock loadings. o Pretreatment (usually neutralization and/or sedimentation) is sometimes required. o Sludge must be properly disposed.
Filtration	o Good for removal of low levels of solids. o Equipment is readily available; easy to operate and control. o Process is easily integrated into overall treatment scheme. o Mobile systems are commercially available. o Backwash water will contain high concentrations of contaminants and must be treated.
Precipitation/Flocculation	o Removes metals and certain anionic species. o Can be used in situ in lagoon wastewater before it is removed. o Equipment is readily available and easy to operate. o Process is easily integrated into overall treatment scheme. o Sludge must be properly disposed.
Sedimentation	o Used as pretreatment for activated carbon adsorption, ion exchange, air stripping, biological treatment, reverse osmosis and filtration. o Sludge must be properly disposed.

APPENDIX 6.5

TABLE 6.5-3

COMMON GROUND-WATER TREATMENT PROCESSES, Continued

Treatment Process	Comments
Ion Exchange	o Removes metals, inorganic anions, and ionized and organic acids. o Rapidly exhausted at high concentrations (2500-4000 mg/l) o Suspended solids greater than 50 mg/l can plug the resin. o Units are commercially available and can be used in mobile treatment systems. o Regenerant solution must be properly disposed.
Neutralization	o Often used to adjust pH prior to biological and other treatment processes. o Relatively simple process.
Air Stripping	o Used to remove volatile compounds. o Less volatile compounds are not removed and must be subjected to other treatment such as carbon adsorption or biological degradation. o Often used upstream of carbon adsorption to reduce the frequency and expense of carbon regeneration. o High energy cost (air flow).
Resin Adsorption	o Very cost-effective for removal of low concentrations of volatile organics. o System is modular and easy to establish on site. o Off-gas may require collection and treatment. o Can remove a wide range of polar and nonpolar organics. o Can tolerate high levels of dissolved inorganics. o Spent regenerant must be properly disposed.
Chemical Oxidation	o Can partially oxidize specific refractory and/or toxic wastes prior to biological treatment (cyanides, phenols, mercaptans and pesticides). o Equipment is readily available but application is complex. o Reagents are hazardous.
Chemical Reduction	o Used primarily for the reduction of hexavalent chromium, mercury and lead. o Equipment is readily available and process is easy to implement. o Capital and operating costs are low.

APPENDIX 6.5

TABLE 6.5-3

COMMON GROUND-WATER TREATMENT PROCESSES, Continued

Treatment Process	Comments
In-Situ Treatment	o Applicability must be detemined on site-specific basis using laboratory and pilot-scale testing.
o Bioreclamation	o Aerobic conditions are usually required (except for halogenated lower molecular weight hydrocarbons). o More soluble compounds are more readily available for degradation. o Other conditions (pH, micronutrients, temperature, etc.) must be suitable. o Hydraulic conductivity must be adequate to maintain a supply of oxygen and nutrients throughout the treatment zone. o Can degrade organics that are sorbed to soils which can not be removed by groundwater extraction.
o Chemical Treatment	o Still in developmental stage. o Groundwater to be treated and the injected reagents must be contained within the treatment zone. o Types of chemical treatment include immobilization, soil flushing, and detoxification. o Soil flushing with water surfactants appears to be relatively feasible and cost-effective for organics. Inorganics can be flushed with dilute acids or chelating agents.
o Physical Treatment	o Still in developmental stages. o Types of physical treatment include in-situ heating, vitrification and ground freezing to immobilize or detoxify contaminants.

Source: References 13, 14, 17, 18, 19 and 20.

APPENDIX 6.6

APPENDIX 6 REFERENCES

APPENDIX 6.6

APPENDIX 6 REFERENCES

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